Tappi

PUBLISHED BY THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

MAY 1951

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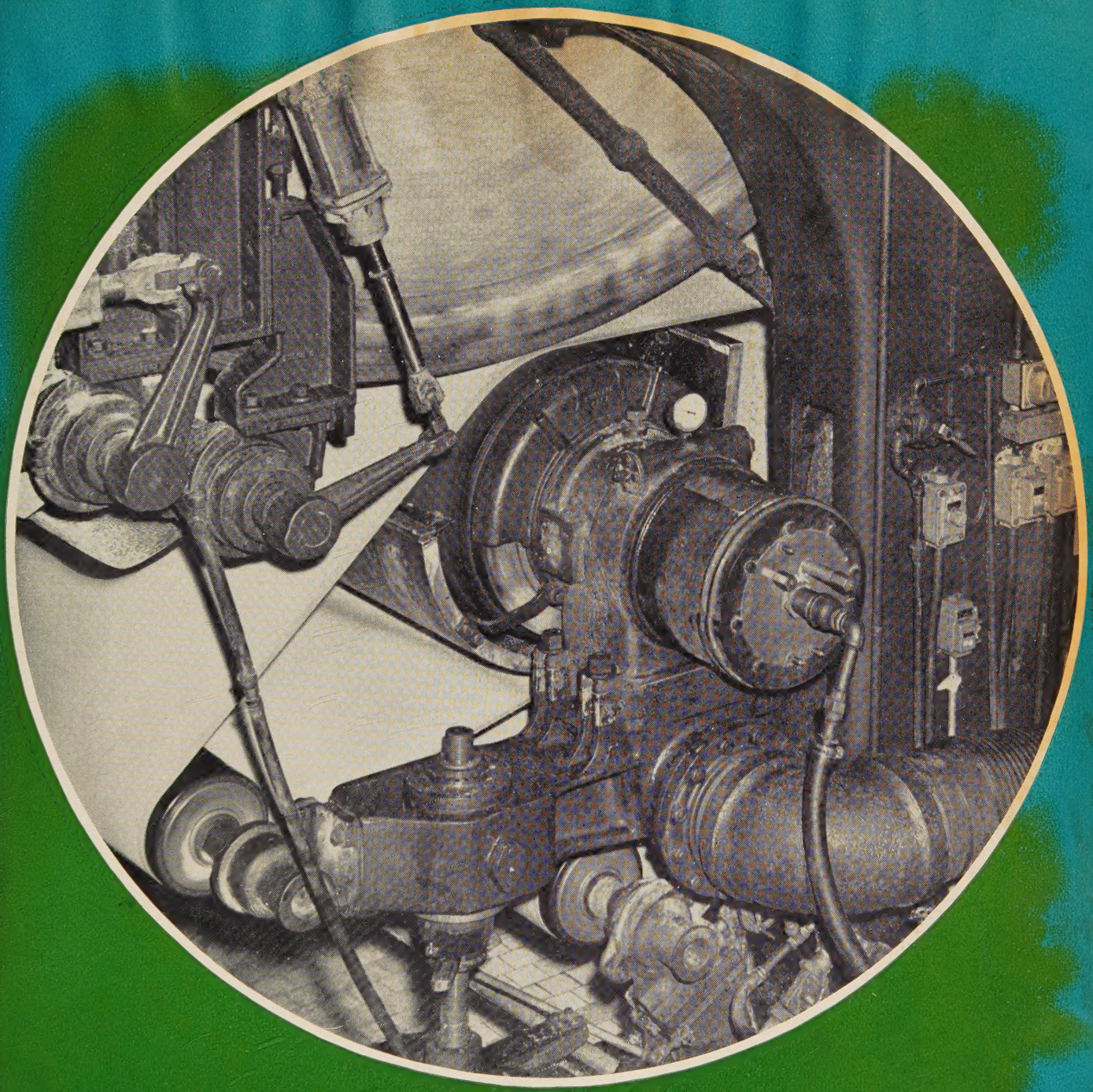

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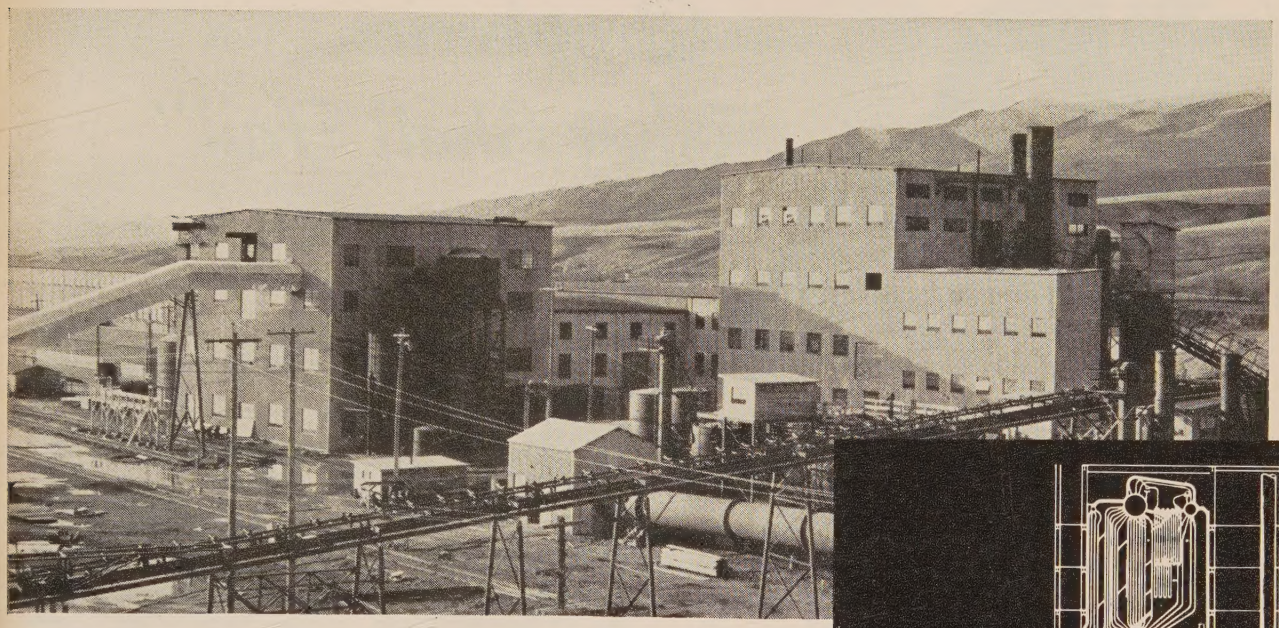

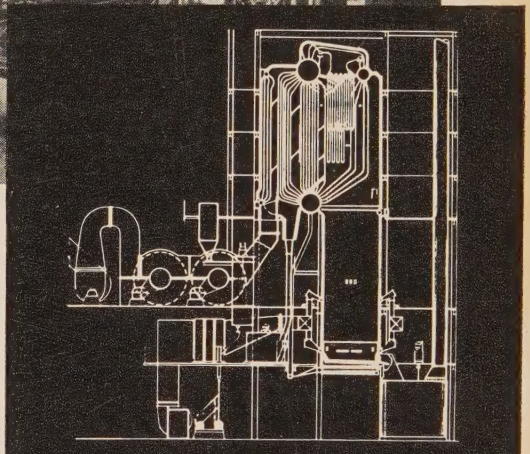

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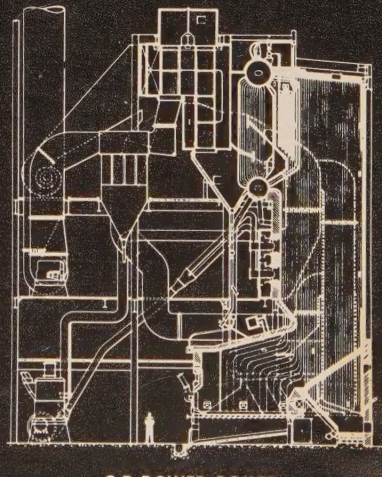

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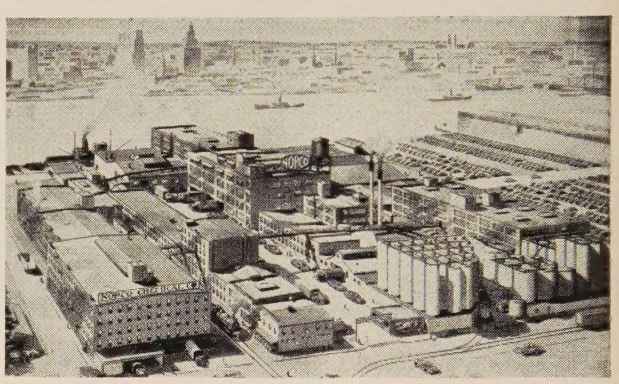
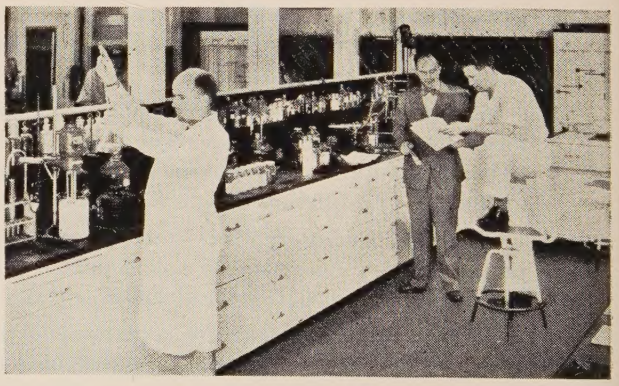


Nopco headquarters — Harrison, N. J.



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VOL. 34 · NO. 5

Published monthly by the Technical Association of the Pulp and Paper Industry

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Published monthly by the Technical Association of the Pulp and Paper Industry at 20th and Northampton Streets, Easton, Pa. Editorial and advertising offices, 122 East 42nd Street, New York 17, N. Y. Articles for publication and communications regarding the editorial content of *Tappi* should be addressed to the Editor at the editorial office. Statements and opinions expressed in articles and editorials appearing in *Tappi* are those of the contributors, and the Technical Association of the Pulp and Paper Industry assumes no responsibility for them. Subscription: U. S. and possessions, $7.50; Canada, $8.25; Pan American Union, $9.00; Other Foreign, $10.00. Single copies to members of TAPPI, $0.75; Nonmembers, $1.00. Entered as second class matter January 27, 1949, at the Post Office at Easton, Pa., under the act of August 24, 1912. Copyright, 1951, by the Technical Association of the Pulp and Paper Industry. An index of the technical articles appearing in the magazine appears in the Industrial Arts Index and the Engineering Index.

Columbium alloy stainless used in Weyerhaeuser Digesters

... to overcome intergranular corrosion near welds

Both of the digesters shown on this page are made of Type 316 Columbium 15 per cent stainless-clad steel. They are part of the equipment the Weyerhaeuser Timber Company recently installed to increase the pulp producing capacity of its Springfield, Oregon, mill from 150 to 250 tons per day.

Columbium alloy was used to eliminate the reduction in corrosion resistance that often exists near the welds in alloy steels. Unstabilized stainless alloys have a tendency to precipitate chromium carbides at the grain boundaries in the parent metal adjacent to the weld. As a result, the chromium content of this region near the weld is reduced—and the metal is less able to resist the attack of corrosive cooking liquors. Columbium is a "stabilizing element" that retards carbide precipitation—and thereby improves corrosion resistance.

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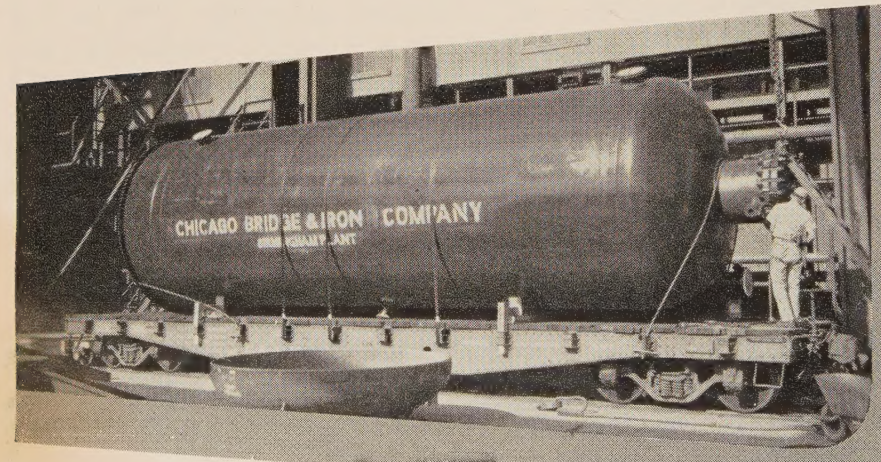

Both of these digesters are 11 ft. in diam. by 30 ft. 11/2 in. long and are made of Type 316 Cb stainless-clad steel.

They were recently installed at the Springfield, Oregon, mill of the Weyerhaeuser Timber Co. as part of an expansion program.

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pH Range	7.5-10.5	9.5-10.5	9.5-10.5	9.5-10.5
Surface Tension (dynes/cm)	30-40	30-40	30-40	30-40
Viscosity (cps)	100 max.	100 max.	50 max.	50 max.
Specific Gravity (dried solids)	0.98	0.98	1.00	0.98
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Stabilizer	NH_4-Soap	NH_4-Soap	NH_4-Soap	NH_4-Soap
Antioxidant	Non-staining	Non-staining	Non-staining	Non-staining
Weight per gallon, lbs.	8.2	8.1	8.3	8.3
Color	White	White	White	White
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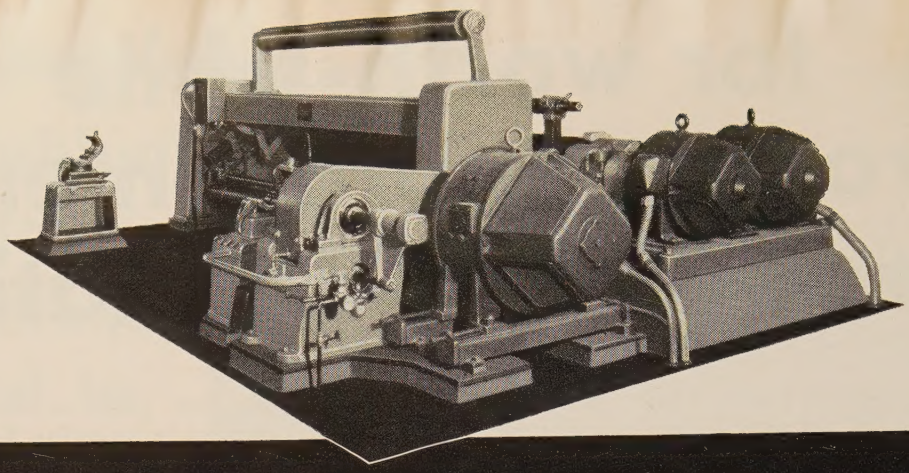

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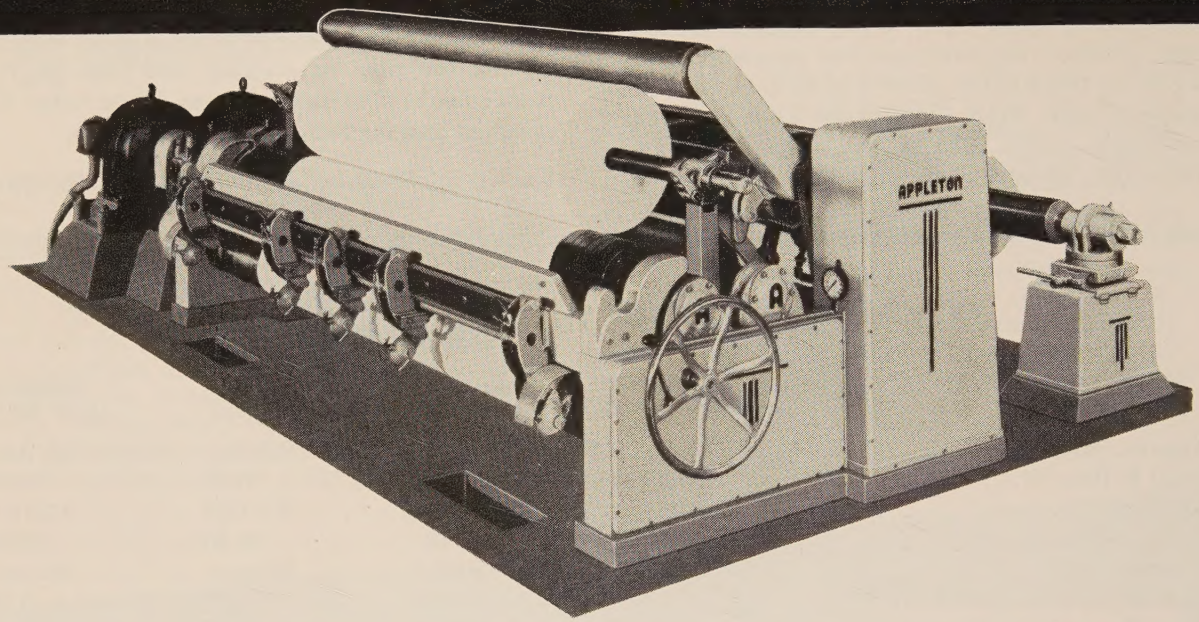

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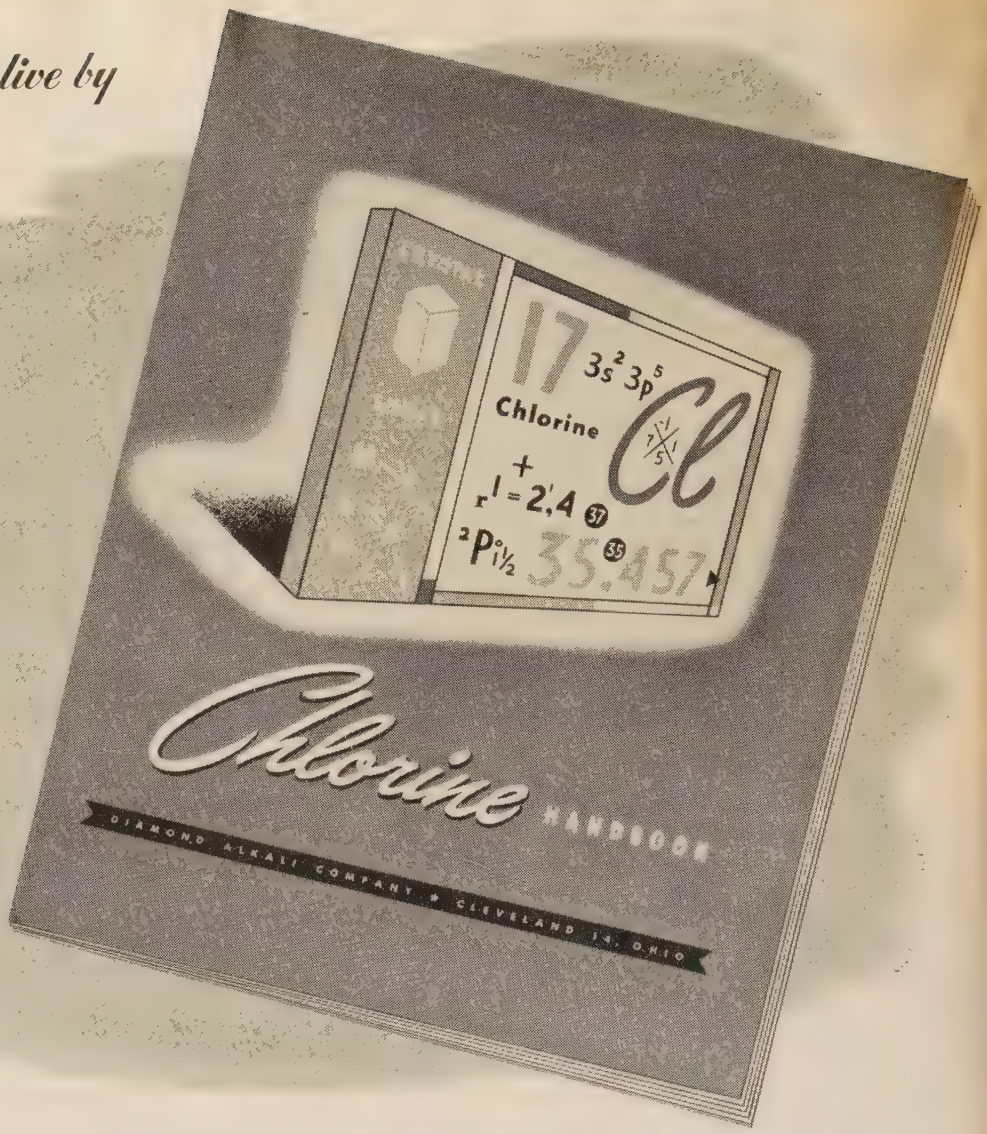

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FEAST OR FAMINE?

GEORGE OLMSTEAD, JR.

Fabian Bachrach

THE paper industry, of which you and I are a part, is an industry which has both assets and liabilities.

Fortunately for us the assets far outweigh the liabilities. Among these assets are a number that are important.

We are the sixth largest industry in our national economy, with assets of well over 5 billions of dollars and with consumers spending approximately 6 billions for our products.

We are a basic industry, for no other industry can long operate without paper. And paper and board—almost like air and water—flow through every phase of human living.

We are an industry that has grown eleven-fold in the past 50 years—from a consumption of $2^1/_2$ million tons per year at the turn of the century to about 28 million tons last year.

We are an industry that is almost unique in having a replaceable raw material—a raw material that can be reproduced over and over again like a crop.

And we are an industry which is predicated on cellulose which is one of the least costly of our basic materials, for which there has never been a substitute but which in turn can substitute for many other materials.

We are an industry that has done a good job in improving the quality of our products and in raising the level of efficiency of our manufacturing operations.

We are an industry that in the past has been willing to lay the dollars on the barrelhead for plant expansion when the growing needs of our customers required that we expand.

Moreover the industry has not been afraid to pioneer totally new areas of production—as the Pacific Northwest was pioneered 30 years ago and as the South was pioneered 15 to 20 years ago.

Now all these things are fine. They are on the credit side of the ledger. They indicate that we have had healthy growth in the past. They would seem to indicate that we could look forward with quiet confidence to continued growth in the future.

But on the debit side of the ledger—on the liability side—there is one serious flaw, and that is the simple fact that our industry has never been viewed favorably by the investment banker or the investing public.

The banks, the insurance companies, the investment trusts, have few—if any—paper stocks in their portfolios. They have oils and rails and chemical stocks, automobiles, and the like, but rarely do you see a paper stock in their lists—with the exception of International Paper Co. and, at times, Scott Paper Co., and a few others.

And, to me at least, it's a sad thing to realize that the sixth largest industry in this country has so little representation when viewed under the cold, impersonal, and, shall I say, fishy eye of the banker.

Now the reason why the bankers don't like us is because we have been in the past a feast or a famine industry—way up or way down. We have lacked continuity of profits, we have lacked reliability of dividends, we have lacked steadfastness of return on the investor's dollar.

Certain it is that in the quarter century from 1920 to 1945 this lack of investment interest in the paper industry was one of our major weaknesses—if not our greatest weakness.

We have had a better situation in this regard in the past 6 years. We have had no famine and as a result the stomach has not become concave. Neither have we had a feast, with its resulting stretching of the waistline. Rather what we have had in these past 6 years has been good, sound eating—neither too much nor too little—and as a result, the investment people at long last have shown some glimmer of interest in the paper industry and are slowly but surely acquiring equities in paper and pulp mills.

This is an encouraging as well as a significant trend because it shows that our industry is maturing and that professional judges (which is what the investment bankers are) are disposed to give us a steadily better rating.

Now why have we improved our sitation latterly?

There are several reasons for that and I am sure they must be obvious to you all.

In the first place, we have gained some 20 million of population in the past decade or so, and you well know that increased numbers of people automatically mean increased consumption of paper products.

On top of that population increase we have enjoyed a high level of economic activity. The faster the top spins the more business there is for all of us.

A third factor in our improvement has been a very important one and that is better economic statesmanship on the part of the leaders in our industry. There is today throughout the operating heads of our various companies a better understanding, I think, than ever before of the intricate relationships of price to demand to production. This has tended to promote sound thinking, not only in connection with the tons produced and the price asked, but also in respect to expansion of

GEORGE OLMSTEAD, JR., President, S. D. Warren Co., Boston, Mass.; President, American Paper and Pulp Association.

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our industry—being sure that the expansion was justified and that the demand was there to absorb the increased production.

And lastly, there is a fourth and very important reason in which you technical people played a major part. Over these last several years you have told us how to reduce our costs. This is a very fundamental point, I think, for if we're smart enough to keep the prices of our products low (and still show an adequate return on capital) the public can afford to be lavish in its use of paper and paper products.

And beyond reducing costs you have developed new products and new uses for old products and these have made important contributions in bettering our over-all financial position in the eyes of the investment bankers and in improving the *safety* of a stockholder's investment in your company and in mine.

Let's get back to this feast or famine situation again. We had famines in the old days and inevitably they came from overproduction in relation to demand. People tried to push the full output of their mills in a market that couldn't absorb all the output and so the prices tumbled down and earnings vanished, and in many instances losses took their place.

When the market turned upward and demand became stronger there was every urge on the part of the manufacturer to enjoy a feast and he did all he could to make it a feast. He had all the perfectly human reactions. If he'd supported his customer by way of low prices for the past year, it was now the customer's turn to support him by way of high prices for the coming year. And if the stockholders ate crow—with no dividends during the poor market—it was only fair and proper that the goose should hang high in the good market—with double dividends to make up.

The famine and the inevitable following feast are the mark of an immature and sophomoric industry.

A more mature industry has thought its problems through. It does not overexpand beyond the real needs of its customers. It does not overproduce in a period of slack demand. It attempts to level out its demand and production relationships.

In short, it makes every effort to maintain an even keel—to stay away from the feast as avidly as it desires to stay away from the famine, and at long last to realize that its real responsibility is to serve the American public. And by public I mean not only the customers who buy our products, but the men and women who work in our mills and the stockholders who have built our mills.

We are well on our way in this process of reaching maturity, and one of the major contributions to our progress in this respect has been the new products which I mentioned earlier and which you men in large part have developed, the new uses for products, and the new things that you have discovered for a product to do.

Just think of what has happened over the past 20 or 25 years. We have seen the multiwall sack substituted in tremendous volume for textile bags. We are right now seeing the paper milk container substitute for the glass bottle. We have seen the shipping carton substitute for wooden boxes. We have seen the individual packing of food products substitute for the old-fashioned cracker barrel. We have seen facial tissue substitute for a cotton handkerchief. In many instances these developments have become major segments in our industry.

Now, these developments accomplish a number of purposes. Firstly—and very obviously—they contribute to the growth of our industry in general. Secondly, they contribute to the profit of the individual company. But thirdly—and most important—if you have new products that give you volume which you otherwise wouldn't have and profit which you otherwise wouldn't have, then automatically there is less pressure on that particular paper mill to deflate values to get volume. These new products, therefore, are a very certain way of easing the pressure on a mill, on its management, and on its sales force. And when you ease these pressures you have a greater continuity of earnings, you have a more stable financial position in the industry, you have more maturity in the industry, and finally there is less jaundice in the eye of the banker who looks at our record.

Now it's true that a major part of this past growth has been in the field of packaging—meaning the carton, the multiwall sack, frozen food containers, etc. But those amazing new industries should not blind us to the fact that an important workmanlike job along the same lines has been done by you men who are particularly interested in the technique of coating.

Over the years you have made a major contribution in improving the quality and serviceability of coated papers, in reducing manufacturing costs, and in opening up new fields.

Running back over the past 20 years in my mind, I think of a number of major developments attributable to this group. The combining of a folding coated and the printing coated into a single paper was a major contribution to the merchandisers and the users of coated printing papers.

The development of quick ink-setting surfaces widened the usefulness of coated paper and led to the speeding up of printing presses and a consequent cost reduction in printed material.

The development of a coated two sides paper for offset lithography widened immeasurably the field for the offset process and permitted the offset lithographer to offer his customer a quality of reproduction that had never been known in the past.

The double coating of paper further improved the surface and uniformity of coated paper while the development of cast coating brought to the public a whole new concept of printing quality, levelness of surface, and the shine that is so important in printed material designed for display purposes.

The development of continuous coating on the paper machine served the obvious purpose of bringing a coated surface to volume industries such as periodical publications, mail order catalogs, and commercial mailings of such size that cost is a predominating factor.

These are not all of the coating developments, by any manner of means, over the past two decades, but they perhaps are the major ones and they are tremendously important because they involve hundreds of thousands of tons of production today. Certainly you know as well as I know that we wouldn't be selling all of this coated paper that we are selling today—whether it be regular coated or cast coated or machine coated or what

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Used to control latex viscosity, Methocel is ideal. It is compatible with most commercially used latices. Methocel is extremely efficient in its thickening ability, giving inexpensive and accurate viscosity control. Also, because Methocel is synthetic and carefully controlled in its manufacture, it is uniform in quality and results.

When used as a coating and sizing agent, Methocel imparts tack-resistance and grease-proof qualities to paper and paper board. It is particularly useful in packaging of sticky or oily substances.

Another useful application of Methocel is as a sizing material that effectively resists penetration of gloss inks, varnishes, lacquers and waxes.

Methocel, the water-soluble synthetic gum, is a chemical of ever-increasing usefulness to the paper industry. A free experimental sample of *powdered* Methocel in a wide range of viscosities is yours for the asking. Write Dept. ME-45, stating potential application.

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CHEMICALS

INDISPENSABLE TO INDUSTRY AND AGRICULTURE

not—unless research work had opened up the door to more serviceable products at relatively lower prices.

You have done your part in the great American concept of making more goods for more people for less money.

There have been minor developments that may become major ones later on. The coating of multiwall sacks with polyethylene; the making of greaseproof wraps for military use as well as commercial use; the products that substitute for textiles—imitation oilcloth and the like, and the products that substitute for metals, such as printing plates for lithographic presses—all these and other similar developments show that the minds of you technical people are still busy digging up new ideas, new things to try.

I always feel that you people have the best end of the business because the possibilities in the coating of paper are fascinating. If you only had ordinary paper to consider, the field is not too wide. It's oversimplification to say so, but in plain paper you are just dealing with pulp of one kind or another formed into a web. You can work on pulpmaking, recovery of chemicals, improving the paper machine, and the like, but the field is restricted and it's pretty tough.

But when you get into coating you have the wide open spaces before you, because you can work on methods of application, different types of materials that can be used in the coating, different methods of finishing. The field is almost limitless.

I have long felt—and I think it is pretty nearly true—that you can do almost anything better with a coated surface. A coated surface will print better, it will varnish better, it will hold up lacquer better, it will lithograph better, it will gravure print better—you name it!

So there is almost an unlimited field in use, just as there is almost an unlimited field in the techniques and possibilities that you might study in manufacture. And it is this happy combination of circumstances which makes me feel that over the rest of your lifetime and mine we shall continue to have an exciting and interesting existence.

We are now in a period, as you all know, where the problem in your mill and in mine and the problem throughout the whole industry, for that matter, is to keep the show going—to keep our production rolling out at present levels. This is a tough period for technical people because your mind is constantly being absorbed in the search for substitutes and in the attempt to piece things out so that production is uninterrupted.

But in spite of all these abstractions, I urge that you never get your eye off the fundamentals in this situation and that no matter how pressing the daily demands may become you still strive for improving your quality and reducing your cost. And above all, that you still strive to develop new products and new uses.

Better qualities, lower costs, and new products will determine how much more we mature in the future and will determine how far we can rid ourselves of the feast and famine liability. This problem rests with you more than with any others, but it may interest you to know that I have such faith in the technical brains of this industry that I think we are starting on our Golden Twenty Years.

1881 **OLD TIMERS** 1951

SIXTY SEVEN YEARS IS A LONG TIME

As we look back and count up and re-count the friendships won and held during this time—we know our business policy is correct. This policy is—To offer a lining and tile tank service of the highest character obtainable—priced on a just, reasonable and equitable basis. In short, there is no juggling with figures so as to give "a little more for a little less".

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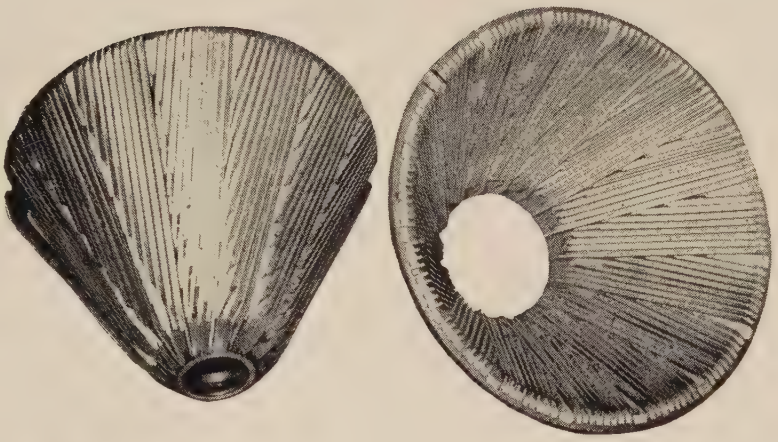

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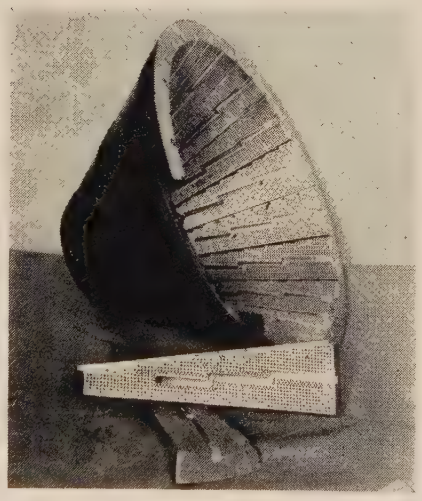

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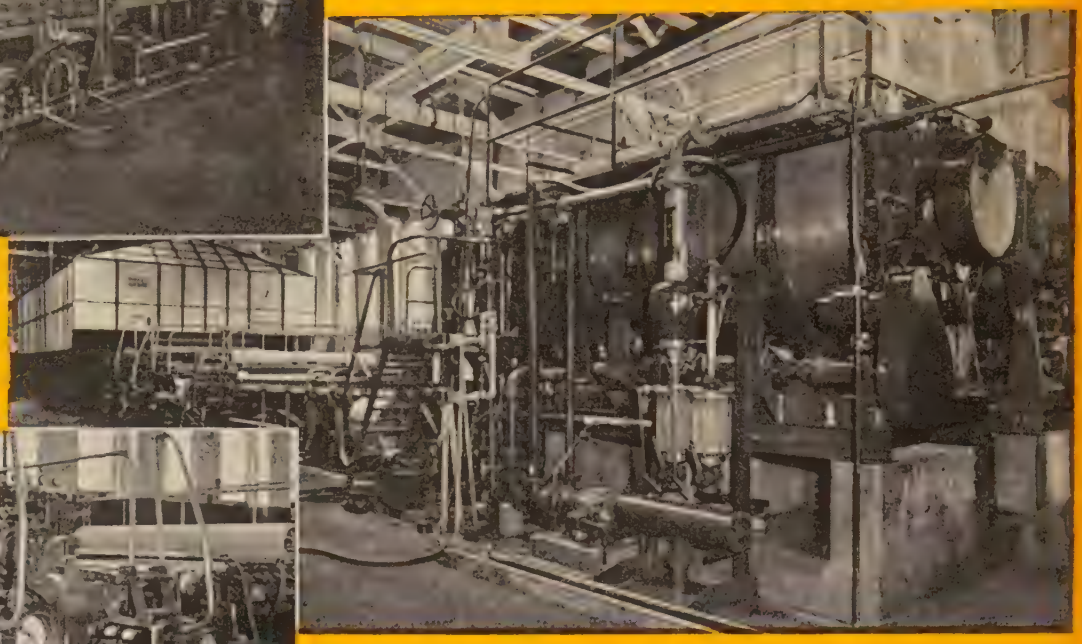
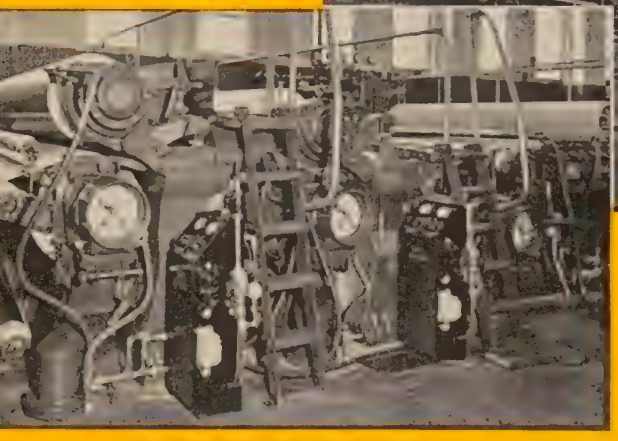
Finch, Pruyn's

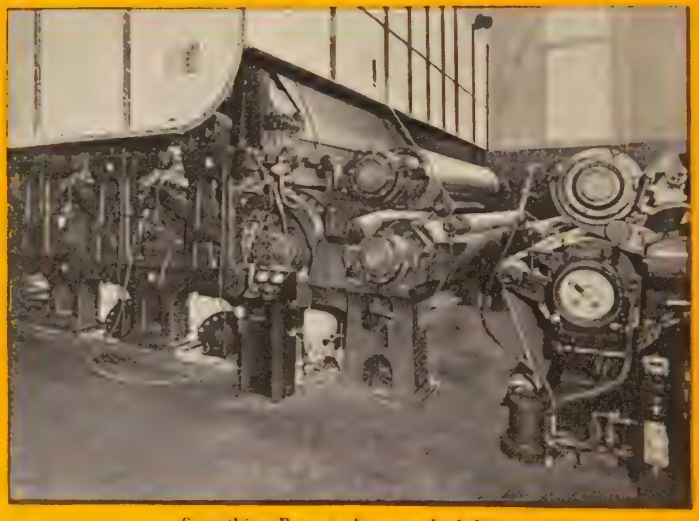
Fourdrinier Wet End

inch Pusey jones Fourdrinier at
n, Pruyn and Company, from wet
with screens in foreground.



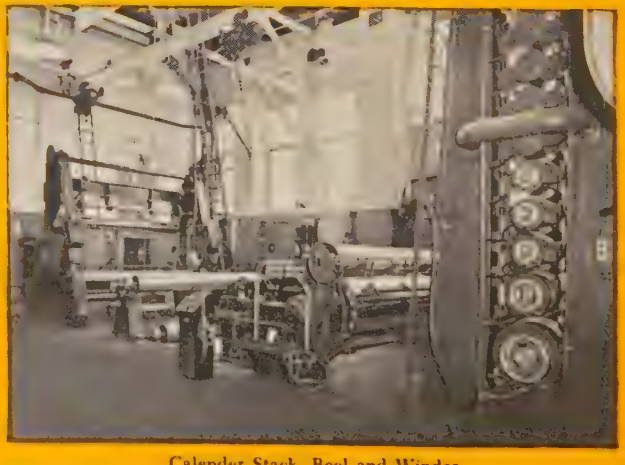


Press Part with two suction presses

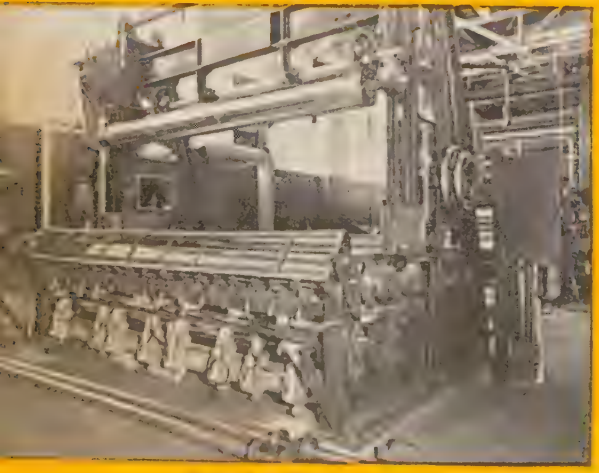


Smoothing Press and wet end of driers

Size Press installed in Dry Part



Calender Stack, Reel and Winder



Slitter and Winder

Change-over

like Military Operation

FEATURES OF 122" "PUSEYJONES" FOURDRINIER MACHINE AT FINCH PRUYN

Improved type Finch Pruyn head box arranged for attachment direct to screens and combined with 60" high fully adjustable slice; all stainless steel construction.

Fourdrinier Part suitable for a wire 75 ft. long, 122" wide, equipped with 30" diameter Downingtown suction couch, 6–7" wide stainless steel suction boxes, 18" diameter Sinclair dandy roll, 5" diameter rubber covered table rolls, 10" diameter brass jacketed wire rolls, high speed duplex shake, 3" permanent pitch wire table, special air-operated handling device for breast roll, copper and brass water piping and showers.

Press Part of improved, close-spaced design with 2–24" diameter rubber covered Downingtown suction presses and 24" diameter granite upper rolls. Pneumatic-controlled pressure loading with both presses of straight through arrangement and felts equipped with Scofield felt conditioners. Wet end smoothing press with 24" diameter bronze cased lower and 24" diameter rubber covered upper rolls.

Dry Part in 3 main sections having one upper and one lower felt on each section; first and second sections each comprising 14 paper and 4 felt dryers; third section, 11 paper and 2 felt dryers; all dryers 48" diameter, designed and constructed for 50 lbs. working steam pressure. Bowser lubricating system for main dryer and drive shaft bearings. Rope carrier device for threading the sheet through the dryer sections. Latest type steam joints with dual revolving siphons. All supporting framework of streamlined box pattern. Hi-tensil alloy gearing with welded steel protective guards.

Size Press comprising 24" diameter chromium plated lower roll and 24" diameter rubber covered upper roll with stainless steel size pan, brass showers, and special Mount Hope type adjustable spread roll.

Calender Stack comprising 10 rolls of 24" diameter bottom, 16" diameter next bottom, and 12" diameter upper, with Bowser oiling system for all roll bearings, pneumatic nip loading system, and Lodding doctors.

Improved Type Pope Reel with pneumatic adjustable loading mechanism and adjustable spreader to handle rolls up to 48" diameter.

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Puseyjones 2-drum winder of improved design, suitable for winding rolls up to 42" diameter, with special arrangement of score-cut slitters; variable speed direct-connected double motor drive.

Mechanical drive for each section with individual enclosed spiral bevel gearing, Airflex clutches and motor-operated belt shifters. Basement line shaft driven from turbine.

All rolls throughout machine equipped with roller bearings and balanced suitable for maximum operating speed of 1000 ft. per minute, except winder at 3800 feet per minute.

There's a new No. 1 Machine at Finch, Pruyn and Company, Glens Falls, N. Y.

The change-over from a 90-inch to a 122-inch Fourdrinier Machine was carried out like a military operation. They had to rebuild the foundation for the wider and heavier new machine. The mill organization worked around the clock to put the new machine into operation without costly change-over.

Here at Puseyjones we are proud of our close association with Finch, Pruyn. Their first two machines — 90-inch and 118-inch Fourdriniers—were built by Puseyjones in 1904. The No. 3 Machine, a 150-inch Fourdrinier, was built by Puseyjones in 1909. The new No. 1 Machine delivered in 1950 represents a new high in the papermaking art. Designed for a speed of 1,000 feet per minute on groundwood specialties, it practically doubled production of the machine it replaced.

Puseyjones engineers will welcome the opportunity to discuss your papermaking problems. If you are thinking of modernizing or adding to your present equipment, get the benefits of Puseyjones experience on Fourdrinier Machines, Cylinder Machines, Yankee Machines, or a modification of any of these types. Write us.

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Established 1848. Builders of Paper-Making Machinery

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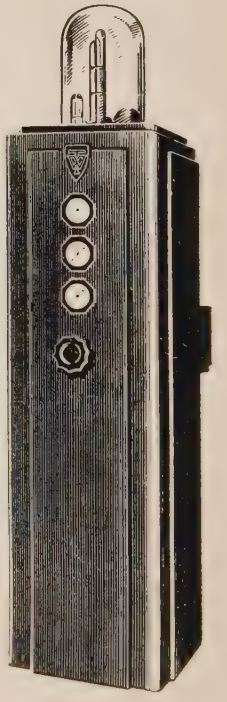
The photograph gives graphic evidence of why Break-Point Chlorination is so effective in eliminating slime in paper mill fresh water supplies. This process, carefully fitted to individual needs by W&T Engineers and applied by dependable W&T Chlorinators, has proven itself in hundreds of modern paper mills all over the country. Such results are obtained because Break-Point Chlorination attacks and destroys the basic cause of slime—bacteria. It does this efficiently and quickly by means of reliable W&T Chlorinators whose effective operation is based on sound design and precision manufacturing — all backed by the accumulated knowledge of over 35 years' continuous experience in every phase of chlorination.

Your nearest W&T Representative—one of a nationwide W&T Service Organization—will be glad to give you details on Break-Point Chlorination for your fresh water supply and chloramine or chemical treatment for stock and white water system. Take the first step toward a slime-free mill. Call him today.



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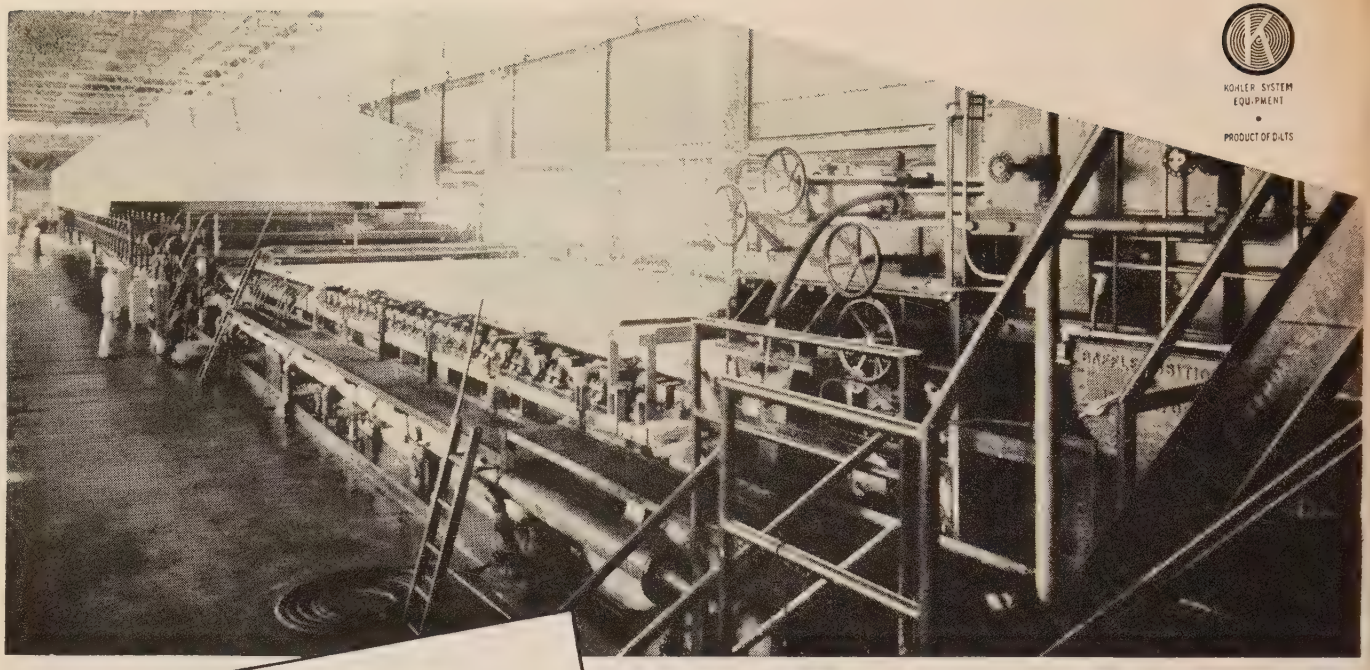

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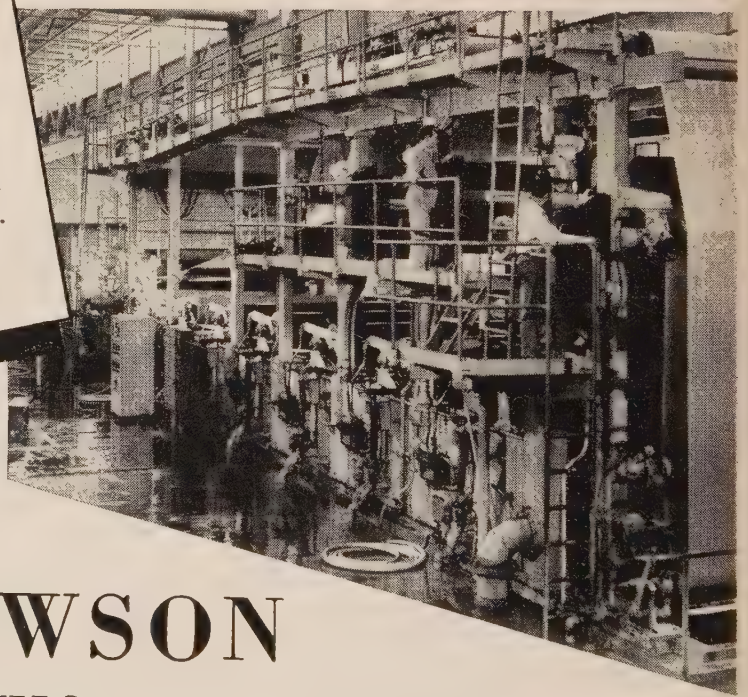

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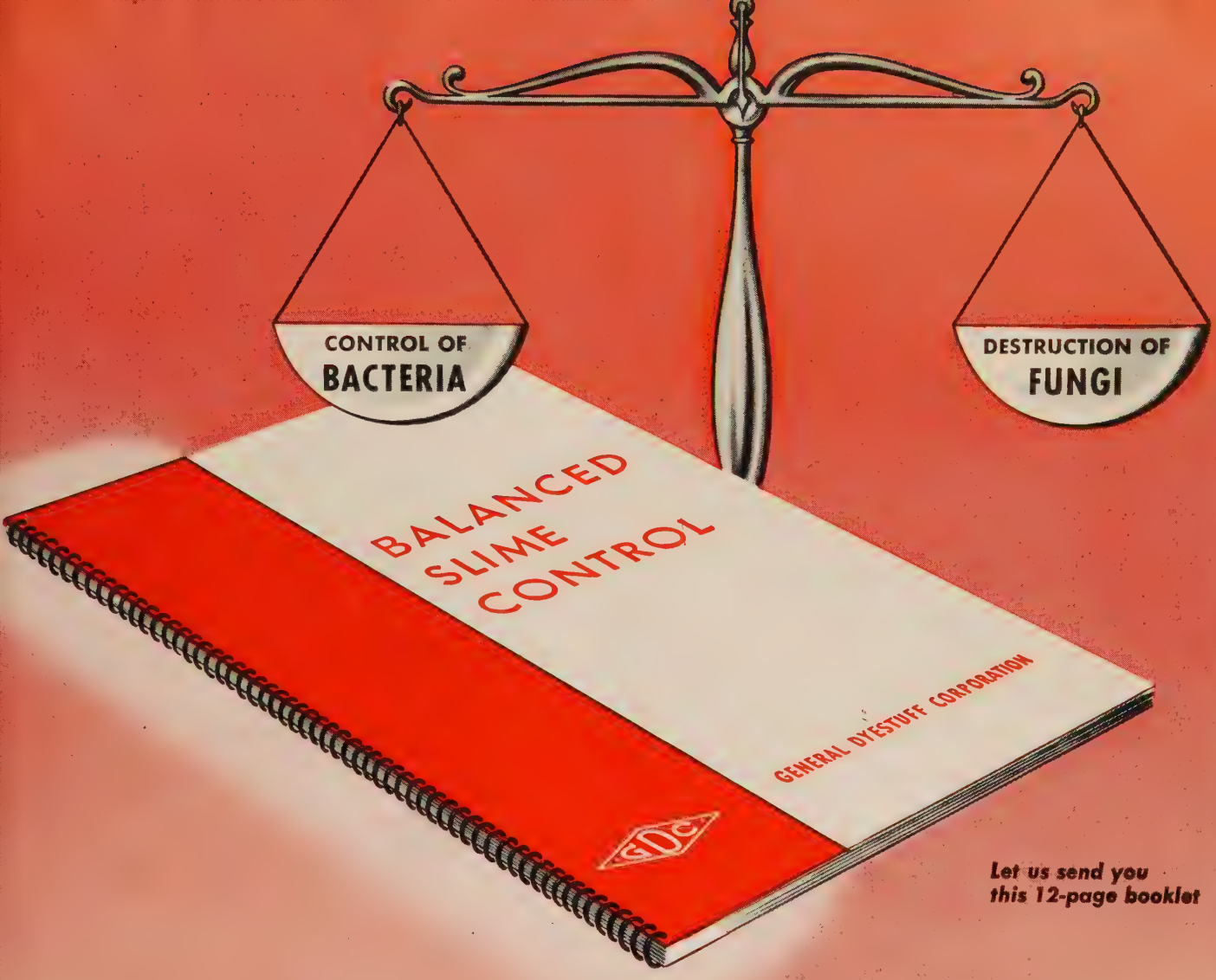

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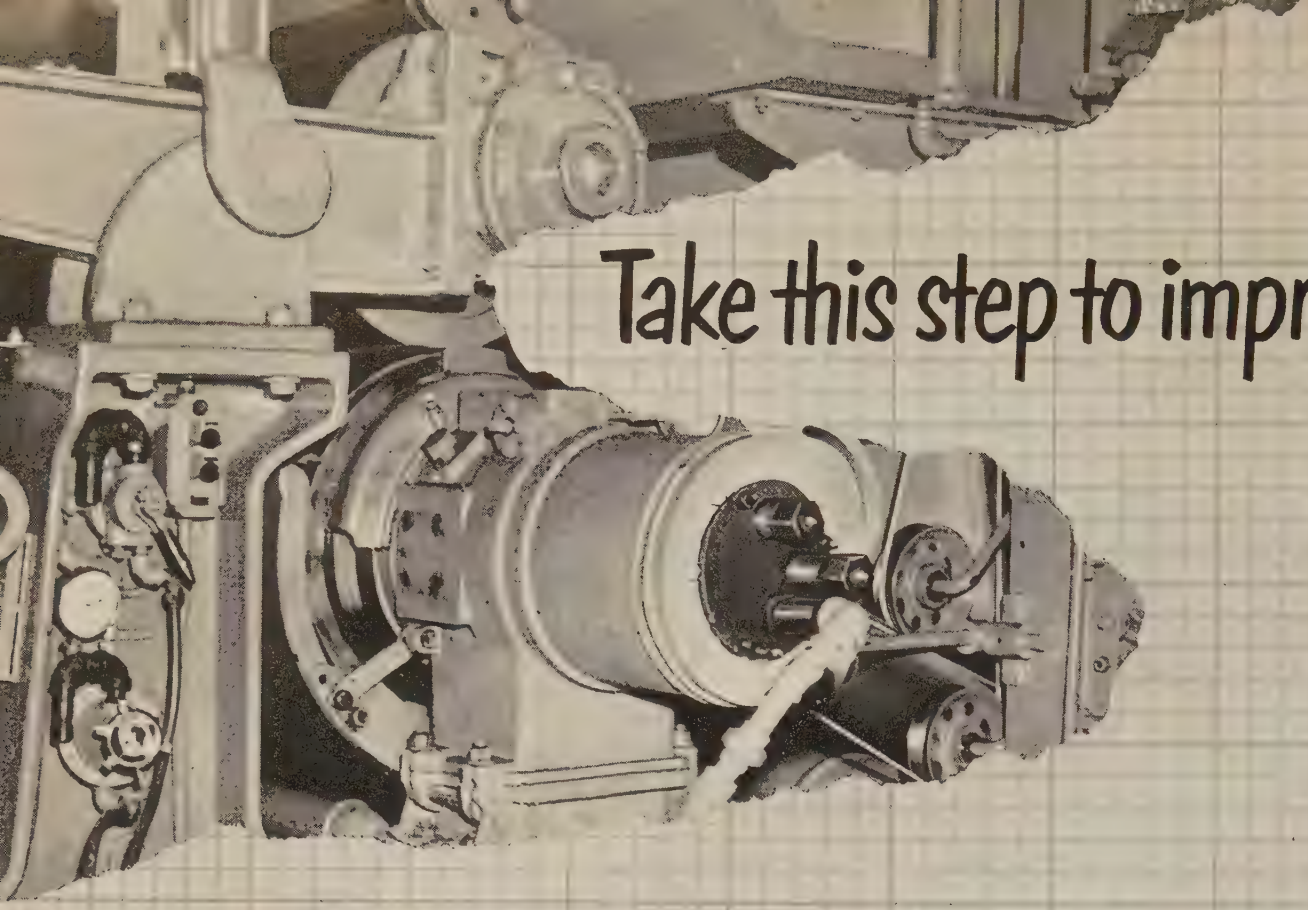

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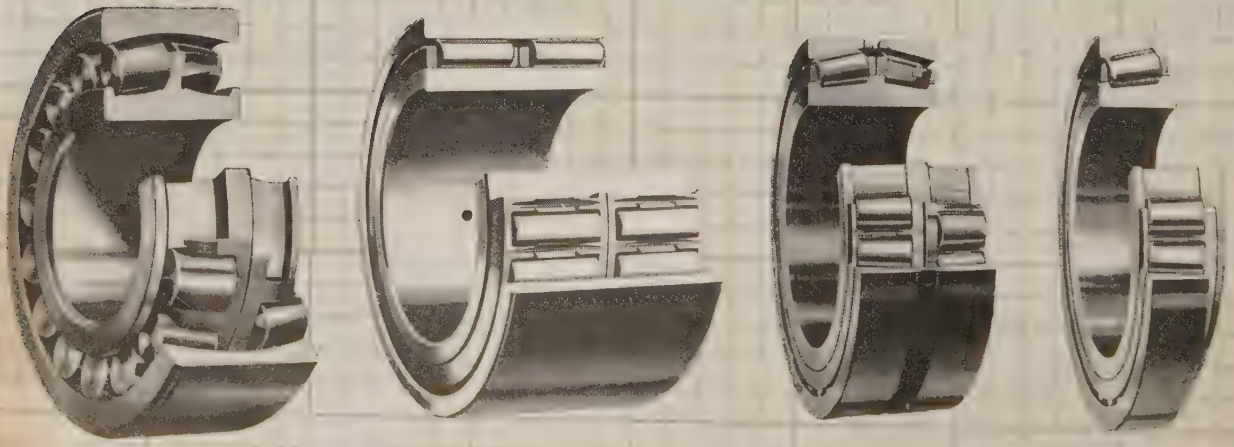

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For years, Torrington has designed and built *all* major types of anti-friction bearings—spherical roller, tapered roller, straight roller, ball and needle. This experience gives our men a talent for making an informed and unbiased appraisal of your problem and assures *the best bearing performance per dollar invested.*

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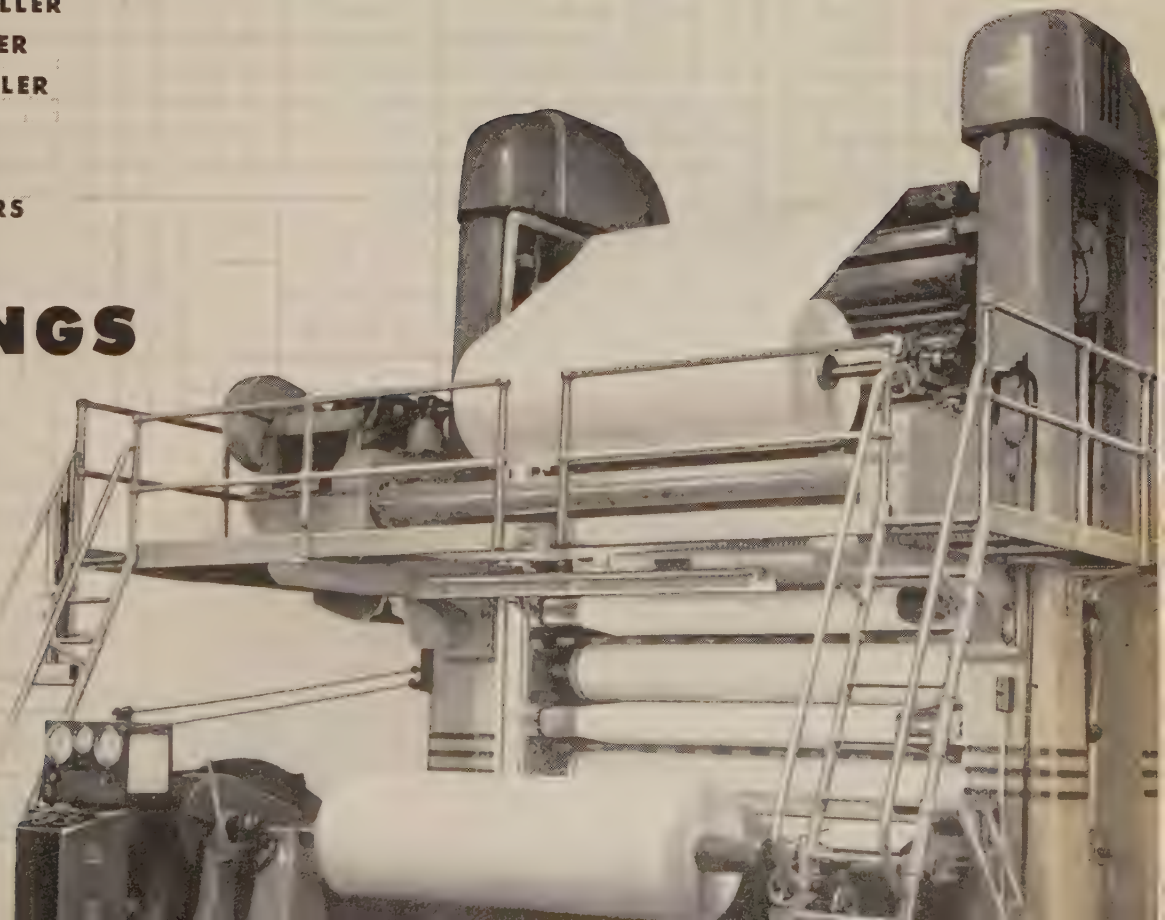
NEEDLE
BALL
NEEDLE ROLLERS

BEARINGS



The What and How of Glassine

An Analysis of the Basic Properties and Applications of This Protective Packaging Paper

GEORGE C. BORDEN, JR., and PAUL K. WOLPER

Those who work with glassine and are acquainted with its special properties do not need any introduction to or definition of glassine. However, for those who may not be familiar with the details of glassine manufacture, it may be worth while to define the paper.

According to the definition given in "The Dictionary of Paper," glassine is a "smooth, dense, transparent or semitransparent paper manufactured primarily from chemical wood pulps which have been beaten to secure a high degree of hydration of the stock. This paper is greaseproof."

In order to secure such a paper as is described in this definition, there are three important points to be emphasized in its manufacture. The key words, as mentioned in the definition, are "dense . . . chemical wood pulps . . . high degree of hydration."

To discuss these briefly:

1. Chemical Wood Pulps. The type of wood used in the manufacture of glassine is usually spruce and the pulp is made by a special sulphite process. Although kraft pulps are used in some furnishes, the bulk of the glassine papers, as we know them today, are made from sulphite pulp.

2. Hydration. The second important point in the manufacture of glassine is the degree of hydration. The mechanical work done on pulp to make it suitable for the production of glassine paper is much greater in magnitude than for any other grade of paper. The desired type of mechanical action is a rubbing and pounding of the fibers without actual cutting. Naturally, with such an amount of mechanical action, the fibers will be broken and cut, but if they can be hydrated and the various fibers can be fibrillated with a minimum amount of cutting, it will give the strongest and most desirable type of pulp for glassine. An example of this is shown in the two photomicrographs (Figs. 1 and 2) depicting sulphite pulp before and after hydration.

Due to the mechanical action which hydrates the stock, the pulp takes on a gelatinous form. Figure 3 shows the strength curves of a typical glassine pulp as it is beaten.

For the nonpapermaker an explanation of the terms used in the figure may be given. "Freeness" is a measure of the rate at which water drains from stock. The test is a wholly empirical one. On the curve it is expressed in milliliters, ranging from 800 to zero, with 800 being the "free" or fast-draining stock, and zero the "slow" or slow-draining stock. Thus, as pulp is beaten and hydrated the water drains more slowly. The strength characteristics, tensile and tear, we believe speak for themselves, while "Mullen," as we all know, is an expression for bursting strength.

In this figure of the strength curves of a typical glassine pulp as it is beaten, it may be noted that the burst and tensile are slowly increased up to a certain point and then tend to decrease. The tear drops almost in a straight line during this beating process, caused by shortening of the fiber. A great many grades of paper are made between the range of 500 to 200 ml. of freeness, but glassine paper is usually made beyond this range, at the end of the scale, from stock that has a freeness of 100 ml. or less. Thus it can be seen that in order to develop greaseproofness and maximum transparency it is impossible to make the sheet at the optimum strength characteristics of the pulp.

The water tends to drain from such a pulp very slowly. Therefore, long fourdrinier wires are necessary and the paper machine is run much more slowly than for other forms of paper, even though the paper made is usually of a light basis weight.

As the pulp slurry is pumped to the paper machine, it is diluted with more water to a concentration of 0.2 to 0.5% solids. This extremely thin slurry is then pumped into the headbox where, by means of automatic precision control, a measured quantity is allowed to flow onto the fourdrinier wire. As the wire moves, water from the mat of cellulose fibrils drains through it, the drainage being assisted at numerous points by the cup-like action of table rolls and suction boxes. When enough water has been removed so that the sheet will support its own weight, it is transferred from the wire and carried by a felt through a series of press rolls which remove more water from the sheet. Next it is passed over a series of steam-heated driers, which drive off all but a small percentage of the remaining water. From the drier section the paper goes onto a reel where it is wound up. At this point the paper is greaseproof, but not glassine.

"Greaseproof" is a term which has been accepted by usage in the paper industry as representing a translucent, machine-finish paper manufactured from wood pulp and hydrated to give grease and oil resistance. This should not be confused with other types of grease- and oil-resistant papers, one of which, as paper men recognize, is vegetable parchment, in which greaseproofness has been obtained by the chemical treatment of a paper with sulphuric acid. Others may be papers which have been coated with grease and oil-resistant films and which therefore represent surface treatment rather than an inherent property of the sheet.

3. Densification. The third step, which makes

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greaseproof paper into glassine, is the densification of the sheet. The sheet is dampened thoroughly with water. This operation is very critical and a very fine, even spray must be formed in order to get the proper amount of moisture into the paper and evenly distributed throughout. The dampened paper is then

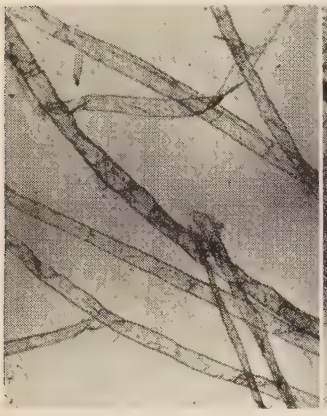

Fig. 1. Before hydration

Fibers of sulphite pulp used in the making of glassine paper are shown here magnified about 120 times.

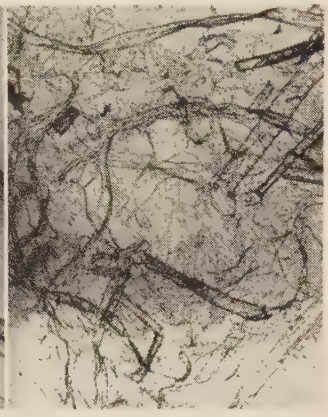

Fig. 2. After hydration

Fibers of sulphite pulp ready to shoot to wire of the paper machine. Magnification here is also 120 times.

supercalendered, where it is subjected to a temperature ranging from 250 to 300°F. The pressure varies according to the grade of glassine and may be as high as 2000 lb. per inch width at the bottom nip. The supercalender is made up of alternating calender rolls of paper and steel. Only the metal rolls are driven. This allows a slippage between the paper and the paper calender rolls, which improves the sheen and gloss of the sheet. To the uninitiated, glassine paper, due to its finish, has the appearance of being a coated sheet, but as can be seen, all of the qualities are produced in the sheet during the complete papermaking process. Naturally the final gloss can be varied, according to customer requirement, by control of the supercalendering.

The supercalendering operation is the point at which the translucency of the greaseproof paper is changed by heat and pressure to the transparency which is characteristic of glassine. The degree of transparency varies, depending upon the qualities desired for the end use of the paper. If the paper pulp has had the maximum degree of hydration a very high order of transparency is possible. In some cases, however, the strength of the paper is of equal or more importance than the transparency. In such cases the fiber length of the paper may be greater, thus allowing for increased tear and strength with corresponding decrease in transparency. The basis weight of the finished sheet will likewise affect the transparency. Naturally the lighter sheets of 16 lb. will be more transparent than sheets of basis weight 30 and 40 lb. Bag papers will usually be made of stronger types of glassine, while cake and tobacco wraps will be made of more transparent grades.

OPAQUE GRADES

However, opaque grades of glassine are made which are not transparent but offer an excellent white printing surface and light protection for many packaged products. This opacity is accomplished by the use of a small proportion of titanium dioxide pigment, which is incorporated in the sheet during the beating operation.

Of all the white pigments, titanium dioxide has the best opacifying property because of its high reflective index. It is this property incorporated in glassine paper which reflects the visible light rays and so prevents their reaching the products packaged in this type of paper and also makes possible the absorption of nearly 100% of the ultraviolet rays. It is this ultraviolet light, that is, the wave lengths from 230 to 390 millimicrons, which acts as a catalyst in the breakdown of fats and oils, resulting in rancidity.

Measurements made of the ultraviolet transmittance of several glassine papers and regenerated cellulose are shown in Fig. 4. The glassine papers tested were all 25-lb. basis weight (24 × 36—500). The regenerated cellulose film included for comparison was a water-vaporproof cellophane of the type used for packaging food products. The papers and film tested were:

A. Clear glassine.
B. Clear regenerated cellulose.
C. Opaque board liner glassine.
D. Snopaque glassine (opaque glassine).
E. Coe green glassine.
F. Tangerine glassine.
G. Goldenrod glassine.

Measurements of each sample were made on the automatic recording Cary quartz spectrophotometer.

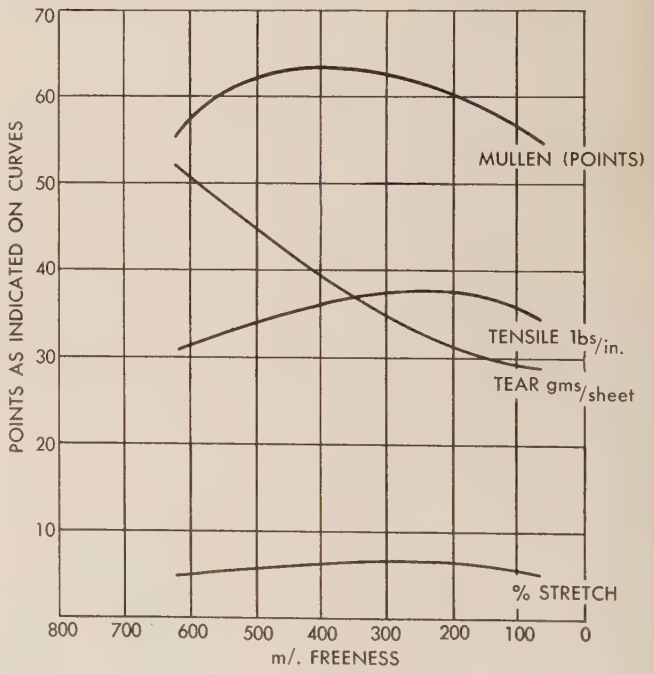

Fig. 3. Strength curves of a typical glassine pulp as it is beaten

A single thickness of each sheet was placed so that the light beam passed through the sample perpendicularly to the surface.

It will be seen from these curves that opaque glassine prevents the passage of the harmful rays of ultraviolet light. Yellow and orange glassine, listed as Goldenrod

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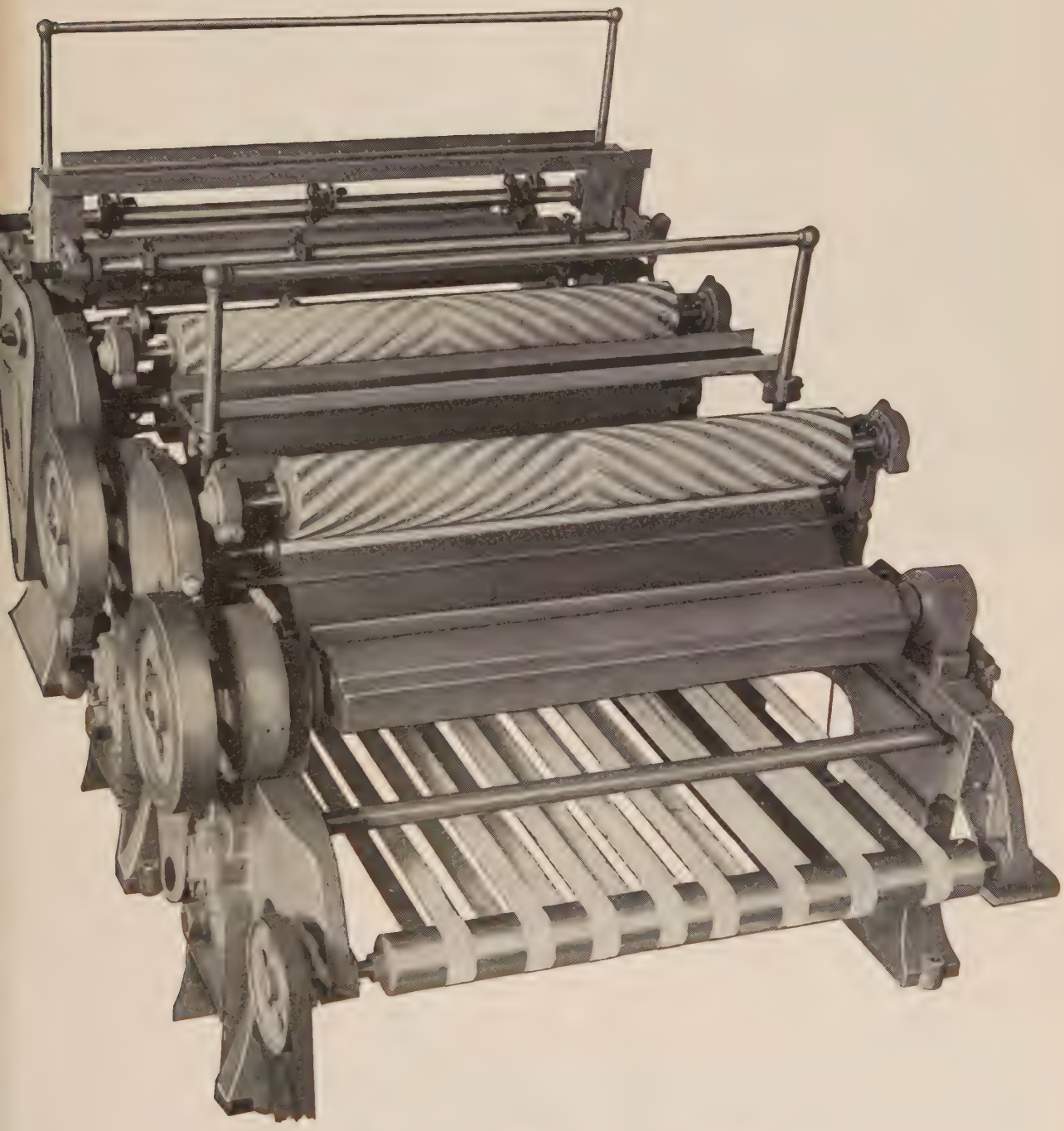

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and Tangerine, also give a fairly effective protection within the same range. However, it should be noted that the opaque glassine is equal to Coe green, which was a special very dark-colored green glassine made especially to prevent rancidity in packaged products. The effectiveness of the use of these glassines for packaging products containing fats and oils which tend to break down, giving off-odors and flavors, can be seen in comparison with regenerated cellulose film, which permits a high passage of ultraviolet light.

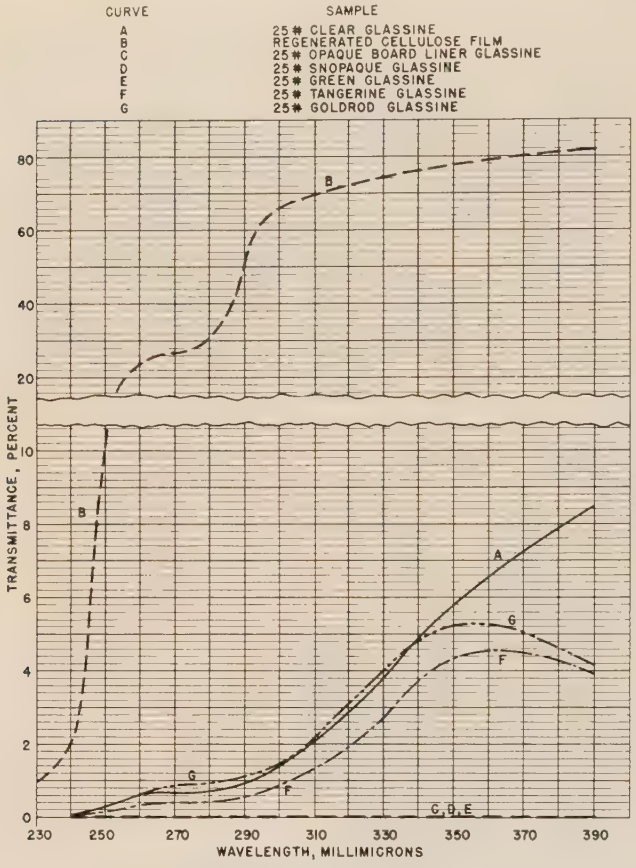

Fig. 4. Glassine papers and regenerated cellulose-UV transmittance of a single thickness, June 7, 1950

The densification of the sheet, which produces the inherent transparency of glassine unless modified as described above, also results in a sheet that is impervious to the passage of air. This accounts for the excellent odor and flavor-tightness of glassine.

To make a summation of the qualities which are the inherent properties of glassine, brought about by the use of special pulp, a high degree of hydration and densification of the sheet by supercalendering, we can list:

1. Resistance to grease.
2. Resistance to oil.
3. Resistance to the passage of odors (flavor-tightness).
4. High tensile strength.
5. Wide range of desired weights (from 15 to 50 lb., 24 × 36—500).
6. High gloss and sheen.
7. Transparency.
8. Suitability for further converting (coatings).
9. Excellent printing surface.
10. Tasteless, odorless, and nontoxic.

Other qualities which may be incorporated during the machine process by chemical additives or control include:

1. Wet strength.
2. Light protection (opaque grades).
3. Wide variety of colors (in both transparent and opaque grades).
4. Increased slip.
5. Increased pliability or flexibility (plasticization).
6. Special neutral grades for noncorrosive papers.
7. Mold retardance.
8. Antioxidant effect.

CONVERTED GLASSINE

The inherent characteristics of glassine paper which differentiate it from other papers are enhanced many times by the variety of modifying operations and materials which are available to the glassine converter. The glassine converter can incorporate into the finished sheet many characteristics which, though more or less dependent upon inherent glassine properties, are entirely distinct from them. These "extra" properties include water-vapor resistance, heat sealability, chemical inertness, and others.

Most important of all in the list of advantages accruing to converted glassine is the flexibility of choice from a wide variety of base glassines which can be combined with other sheet materials, enabling the converter to custom build specialty grades to satisfy specific end-use requirements. It has been due to this flexibility of manufacture that converted glassine has kept pace with and contributed to the enormous development of unit-size packaging and marketing of food and other products at lower cost and of improved uniform quality which has occurred in this country during the past two decades.

It is perhaps a commonplace to state that any package, regardless of its size or shape, package material or product packaged, must serve three basic functions: visual, structural, and protective. We are primarily concerned in this general discussion with the products of glassine converting processes and materials in so far as they contribute to and fulfill their manifold protective functions. The equally important visual and structural functions of converted glassine are given undeservedly brief consideration at this time only as they are related to the protective functions.

COATINGS AND LAMINATIONS

Coatings and laminating are the principal converting operations by which the basic protective characteristics of glassine are enhanced or new ones created. The following outline indicates the fundamental types of converted glassines and other sheet materials:

A. Waxed papers
   1. 100% refined paraffin wax
   2. Modified paraffin wax
   3. "Hot melts"
B. Solvent coated papers
   1. Nitrocellulose coatings
   2. Natural and synthetic rubber derivative coatings
      (a) Cyclized rubber
      (b) Chlorinated rubber
      (c) Butadiene-styrene copolymer coatings

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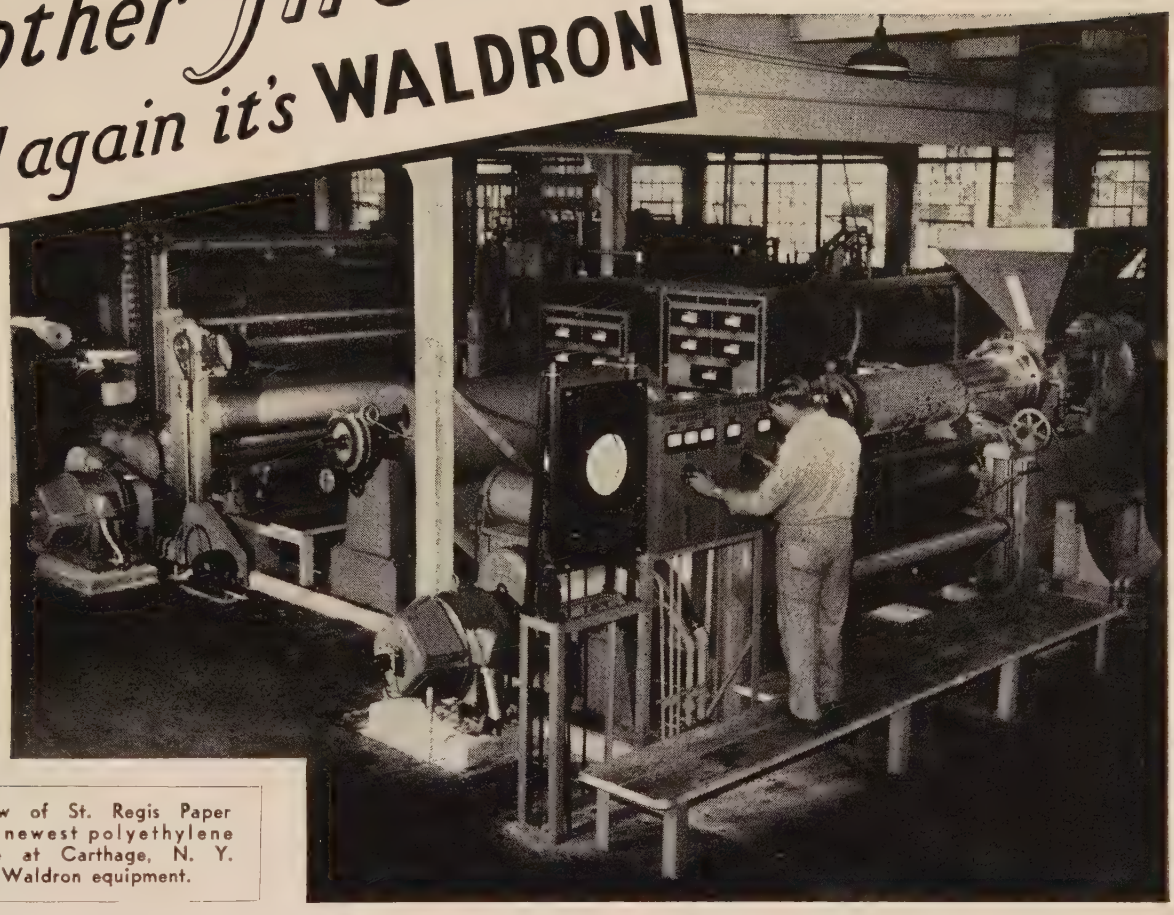

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Table I. Properties of Coated Glassines and Allied Sheet Materials

Base paper Type	Wt., lb.	Coating Type	Wt., lb.	WVTR G./100 sq. in./24 hr. Flat	WVTR G./100 sq. in./24 hr. Creased	Heat seal	Blocking	Grease-proofness	Other properties
Glassine									
Hi transparency	20–25	100% refined paraffin wax	3–4	0.2–0.4	3.0–5.0	Poor	Poor	Good	High gloss. Very good transparency
Medium transparency	25–30	100% refined paraffin wax	3–4	0.2–0.4	3.0–5.0	Poor	Poor	Good	High gloss. Good transparency
Low transparency	25	100% refined paraffin wax	5–7	0.1–0.2	2.5–3.5	Poor	Poor	Fair	High gloss. Fair transparency
Amber glass	29	100% refined paraffin wax	4	0.2–0.4	3.0–5.0	Poor	Poor	Good	High gloss. Fair transparency
Neutral glass	25–40	100% refined paraffin wax	4	0.2–0.4	....	Poor	Poor	Good	High gloss. Fair transparency. Anticorrosive use
Sulphite or kraft	25	100% refined paraffin wax	5	15.0–30.0	....	Fair	Fair	Poor	.....
	25	100% refined paraffin wax	10	0.7–2.0	9.0–12.0	Fair	Poor	....	.....
Vegetable parchment	32	100% refined paraffin wax	8	0.4–0.6	....	Poor	....	Good	Wet strength
Glassine	25	Modified paraffin wax	5	0.2–0.4	3.0–5.0	Fair	Poor	Good	Improved flexibility of film
Sulphite or kraft	25	Modified paraffin wax	10	0.3–0.5	5.0–8.0	Good	Fair	....	Improved flexibility of film
Sulphite or kraft	25	Hot-melt coatings	10	0.5–2.0	....	Excellent	Fair	Poor	Very good gloss. Flexible film
Glassine	22–25	Nitrocellulose solvent coated	3	0.4–0.6	4.0–6.0	Good	Good	Excellent	.....
	25	Nitrocellulose solvent coated	3	0.8–1.2	5.0–7.0	Good	Good	Excellent	Spec. high WVP for breadwrappers. Available with antimold treatment
Sulphite or kraft	22–32	Nitrocellulose solvent coated	5–8	0.7–1.4	5.0–8.0	Very good	Fair to good	Excellent	.....
Vegetable parchment	32	Nitrocellulose solvent coated	8	0.9–1.5	5.0–8.0	Very good	Good	Excellent	.....
Glassine	22	Pliolite cyclized-rubber solvent coated	3	0.15–0.25	0.4–0.8	Very good	Good	Fair to good	Available with antimold treatment
	25	Pliolite cyclized-rubber solvent coated	3	0.15–0.25	0.4–0.8	Very good	Good	Fair to good	.....
Sulphite or kraft	25	Pliolite cyclicized-rubber solvent coated	5	0.30–0.50	0.9–1.2	Very good	Good	Fair	.....
	32	Pliolite cyclicized-rubber solvent coated	8	0.30–0.50	0.9–1.2	Very good	Good	Fair	.....
Glassine	22	Vinyl polymers solvent coated	3	1.0–3.0	....	Good	Good	Excellent	Added greaseproofness, good chemical resistance
Glassine	22	Polyamides solvent coated	3	0.5–3.0	....	Good	Good	Excellent	Added greaseproofness

3. Other coatings
   (a) Vinyl and vinyl copolymer coatings
   (b) Polyamide coatings
   (c) Polystyrene coatings

C. Laminated papers
1. Materials
   (a) 100% microcrystalline wax
   (b) Modified microcrystalline wax
   (c) Aqueous or organic dispersions of glues or resins
2. Combinations
   (a) Glassine to glassine
   (b) Glassine to paper or board
   (c) Glassine to synthetic film
   (d) Glassine to metallic foil

The above outline is given in expanded form in Tables I and II, which include experimental data on some of the principal protective properties of these converted glassines and other sheet material products. All weight figures given are expressed on the 24 × 36—500 ream basis. Water-vapor transmission rates, expressed as grams per 100 sq. in. per 24 hr., were determined at 100°F. by the General Foods method. Heat-sealing characteristics, more properly a structural than a protective function, were determined with a Wrap-Ade bag sealer at a temperature of 200 to 220°F. Blocking characteristics, ofttimes extremely important in package fabrication or storage, were determined at 120°F. for a 24-hr. period under a pressure of $^1/_2$ p.s.i.

No numerical values are given to describe the greaseproof property of the various sheet materials. This is due to the fact that the base papers exert a tremendous influence upon the final greaseproofness obtained. As has been explained previously, glassine, being hydrated, dense, and hard surfaced, is inherently grease resistant, while other types of sulphite or kraft papers (excepting vegetable parchment), even though supercalendered, have no greaseproofness unless treated further with coatings.

(*Continued on page 38A*)

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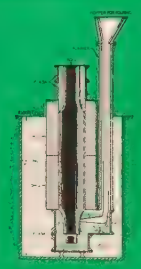

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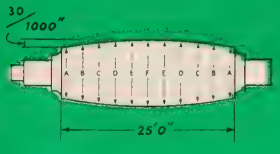

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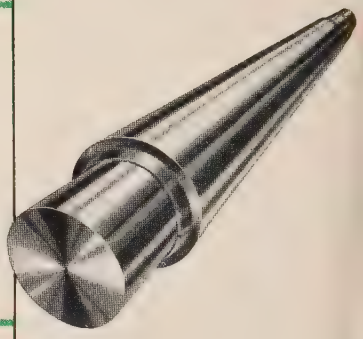

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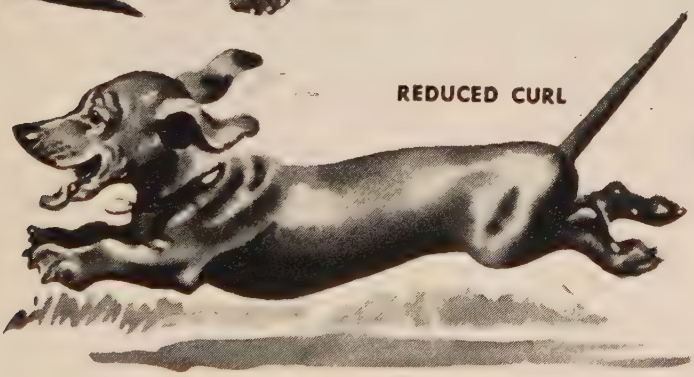

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Table II. Properties of Laminated Glassines and Allied Sheet Materials

Base paper		Laminant		WVTR G./100 sq. in./24 hr.		Added greaseproof	Other properties
Type	Wt., lb.	Type	Wt.	Flat	Creased		
Glassine to glassine	2–22½ and 2–25	100% Microcrystalline wax or modified wax	7 lb.	0.3–0.7	0.3–0.7	Excellent	Modified microcrystalline waxes have improved bond strength
	2–25	100% Microcrystalline wax or modified wax	10 lb.	0.3–05.	0.3–0.5	Excellent	
Glassine to sulphite or kraft	2–25	100% Microcrystalline wax or modified wax	5 lb.	1.0–2.0	2.0–4.0	Good	
	2–25	100% Microcrystalline wax or modified wax	15 lb.	0.3–0.5	0.5–1.0	Good	
Glassine to 300 MST cellophane	45	100% Microcrystalline wax or modified wax	7 lb.	0.3–0.5	.....	Excellent	Very high gloss
Glassine to aluminum foils	40	100% Microcrystalline wax or modified wax	7 lb.	0.01–0.02	0.15–0.30	Excellent	
	40	(Resin emulsion)	1 lb.	0.01–0.02	0.4–1.0	Excellent	
Glassine to glassine	2–25	(Resin emulsion)	1 bl.	High	High	Excellent	Extra greaseproofness
Glassine to glassine	2–25	Modified nonpetroleum	10 lb.	High	High	Excellent	Pliability, anticorrosive
Glassine to glassine nitrocellulose coated	2–25	100% Microcrystalline	4-C	0.15–0.25	0.20–0.40	Excellent	Heat sealing, high gloss
Glassine to glassine rubber-derivative coated	2–25	100% Microcrystalline	3-C 7-W	0.10–0.15	0.20–0.40	Excellent	Heat sealing
Glassine to aluminum foil nitrocellulose coated	40	100% Microcrystalline	3-C 7-W	0–0.01	0.15–0.30	Excellent	Heat sealing

MOISTUREPROOFNESS

The function of moistureproofness is undoubtedly the most important of all of the protective functions which are required of any sheet packaging material. There are relatively few products that do not require some degree of protection against moisture change, either as moisture gain or moisture loss. Instant coffee powders, for example, require a high level of moistureproofness from the package material, since the gain of only a slight amount of water will cause the product to cake and become unusable, while in the case of tobacco products, valuable product quality is lost with the loss of moisture.

Moistureproofness is efficiently and economically achieved with glassine by virtue of the very characteristics which make it greaseproof. Its hard, smooth surface lends itself admirably to the application of moistureproofing films by the waxing or solvent-coating operations that have been indicated in the foregoing list. At the same time, the surface appearance of the glassine and its printing are enhanced by the added surface film.

Refined paraffin wax is at the same time the cheapest and most moistureproof of the coating materials. On glassine it results in a film of high gloss and transparency and of a high order of moistureproofness. Examples of products wrapped in waxed glassine are cakes and potato chips. Waxed glassines are also used in cereal boxes and in cracker boxes.

The paraffin wax is applied in the molten liquid state at temperatures from 160 to 200° F., depending in part on the melting point of the paraffin-wax grade used and in part on the type of waxing desired. Paraffin-wax coatings are subject to some disadvantages in that they are soft and flaky and hence are easily marred and block readily. Straight paraffin-wax coatings are heat sealing, but the bond does not have sufficient strength for most waxed-glassine packages, so that in the case of bag seams and the like, glue is more often used. When used for carton liners the heat seal of wax is usually satisfactory.

Paraffin wax may be modified with microcrystalline waxes, compatible resins, or rubber derivatives. These are on the market under trade names such as Bradtite, Glosseal, Rapin-wax. The modified blends result in films with improved and, for automatic packaging, satisfactory heat-sealing and blocking characteristics. These improvements, in some instances, are obtained at the expense of moisture-proofness.

It is possible to carry the modification of refined paraffin wax to the point that the paraffin component of the blend is only a small percentage of the total material involved. As this point is approached, or as the paraffin-wax component decreases in concentration, application temperatures of the blend increase, until the realm of the so-called "hot melts" is reached. "Hot melts" generally require application temperatures in excess of 250 to 300°F. and consequently are rarely applied to glassine or greaseproof papers due to embrittling and a lower order of moistureproofness of the "hot-melt" materials. Hot melts can, however, be applied to sulphites, krafts, or vegetable parchment and result in coating films of extraordinary gloss and heat-sealing strength, but with relatively low moistureproofness.

SOLVENT COATING

The fundamental moistureproofing characteristics of refined paraffin are used to great advantage in the solvent-coating field. Nitrocellulose coatings, which by virtue of low cost, heat sealability, greaseproofness, film gloss, and transparency are the most widely used of the solvent-applied materials, depend entirely upon the presence of very small percentages of refined paraffin for their moistureproofness. Paraffin is incompatible with nitrocellulose, so that in solvent removal during the film-casting operation the paraffin is "kicked out" or rejected by the nitrocellulose dispersion, forming a minute but extremely effective water-vapor barrier on the surface of the dried film.

As noted before, nitrocellulose is inherently greaseproof and resistant to aliphatic and aromatic hydrocarbons, fats and oils, and is admirably suited for use in packaging applications requiring good heat seals com-

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Table III. Converted Glassine in Protective Packaging

Product	Package material	Package types	Requirements: Moisture-proofness	Requirements: Grease-proofness	Requirements: Other
Bakery products					
Bread	Waxed sulphite or coated glassine	Overwrap	Low	Low	Mold inhibition
Cupcakes	Waxed or coated glassine	Overwrap	High	High	Mold inhibition
Crackers, cookies	Waxed or coated glassine	Carton liner	High	High	
Pastries	Waxed or coated glassine	Overwrap	Medium	High	Mold inhibition
Beverages					
Coffee—whole bean	Laminated glassine	Bag liner	Low	High	Flavor retention
Coffee—ground	Coated supercalendered kraft or vegetable parchment	Heat-seal bag	Medium	High	Flavor retention
Coffee—instant	Coated laminated foil glassine	Heat-seal envelope	High	High	Flavor retention
Cocoa—instant	Coated S. C. kraft coated laminated glassine	Carton liner Heat-seal envelope	Medium	Medium	Flavor protection
Fruit—instant	Laminated coated glassine or glassine-foil	Heat-seal envelope	High	Low	
Breakfast cereals	Waxed opaque sulphite Waxed glassines	Carton overwrap Carton liner	Medium	Low	Flavor retention
Candies					
Chocolate bars	Opaque glassine	Inner wrap	Low	High	Odor retention
Chewing gum	Laminated glassine	Wrapper, carton Overwrap	High	Medium	Flavor retention
Sen-Sens	Waxed glassine	Cups	Low	High	
Sugar	Coated S. C. sulphite	Heat-seal envelope	Medium	Low	
Dairy products					
Cheese	Laminated foil-glassine	Wrapper	High	High	Wet-strength
Powdered milk	Laminated glassine Laminated foil-glassine	Carton liner Heat-seal envelope	High	High	
Butter	Vegetable parchment	Inner liner	Low	High	Wet strength
	Wet strength greaseproof	Inner liner	Low	High	Wet strength
Dehydrated foods					
Powdered eggs	Laminated coated glassine Laminated foil-glassine	Heat-seal envelopes	High	Low	
Soup mixes	Laminated foil-glassine	Heat-seal envelopes	High	High	
Yeast	Laminated coated glassine or foil-glassine	Heat-seal envelopes	Medium to high	Low	
Frozen foods					
Vegetables	Coated kraft Wet-strength laminated glassines	Carton liners, or wraps and bags	Medium	Low	Wet strength
Fruits	Laminated glassine-kraft Coated kraft	Bags	High	Low	Wet strength
Meats	Waxed laminated glassine to kraft	Overwrap	Medium	High	Blood resistance
Specialty Foods					
Popcorn	Waxed glassine Coated and/or laminated glassines	Glue-seal bags	High	High	Antirancidity
Potato chips Fritos	Waxed glassine Coated and/or laminated glassines	Heat-seal bags	High	High	Antirancidity
Prepared mixes					
Cake and pie mixes	Laminated glassine	Carton liners	Medium	High	
Pudding mixes	Laminated glassine	Carton liners	Medium	High	
Meat and fish	Waxed or coated kraft coated glassine	Overwrap	Medium	High	Wet strength, blood resistance
Cosmetics	Coated glassine Coated laminated glassine	Cap liner Four-side-seal envelope	Medium High	High	Odor retention
Tobacco	Coated glassine Coated supercalendered kraft	Carton overwrap Pouch	High	Low	Antimold
Chemicals	Coated supercalendered sulphites or kraft Coated laminated glassine	Heat-seal envelopes	Low to high	Low	Specific chemical resistances
Medicinals	Coated laminated glassine Foil-glassine laminates	Heat-seal envelopes Cap liner	Medium High	Low	Specific chemical resistances
Metal goods	Waxed glassine Laminated glassine	Wrappers Heat-seal envelopes	High	High	Neutral pH low chlorides and sulphides. Anti-corrosion and antitarnish
Soaps	Waxed glassine	Inner wrapper	Low	Low	Alkali resistance

bined with grease and moistureproofness together with attractive visual characteristics, such as tobacco, cheese curls, and potato chips.

Rubber derivatives of the Pliolite or cyclized-rubber types have come to be used increasingly since the end of the war. For automatic packaging they assure positive heat seals and an inherent moistureproofness approaching that of refined paraffin wax. They form clear, transparent films of surprising toughness and flexibility. These overcome one of the disadvantages of nitrocellulose and paraffin wax films by having unusually good moistureproofness after creasing, a fact of great importance to the bagmaker. They are affected to some extent by fats and oils and are not recommended for extremely greasy products. Hygroscopic materials which are packed on automatic packaging equipment of the envelope or pillow type, such as dried yeast, hair rinses, and powdered medicinal products, use this type of coated glassine.

Solvent coating affords the glassine converter and the ultimate consumer an economical application of the fairly recent synthetic organic polymers, some of which have already been listed. Their importance, tonnage-wise, is not as yet fully realized, but they are of great

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importance when their special characteristics are required. There are applications, for example, where the solvent resistance of the principal glassine-coating materials previously mentioned is not adequate. These "blind spots" many times can be filled in with a vinyl co-polymer, a polyamide, a polystyrene, or other synthetic coating on glassine at a cost lower than a cast film of these same materials. Generally speaking, however, these materials are selected for some specific end use rather than for all-purpose usage.

Solvent coatings may also be modified by the incorporation of nontoxic reducing agents which retard oxidative rancidity in foods containing fats or oil, such as potato chips. Similarly, fungicides may be added to inhibit mold growth on packaged products such as chewing tobacco or jellies. Along the same lines, development of an insect-repellent coating is currently under way.

PROPERTIES OF LAMINATIONS

It remains for the second type of glassine-converting operation, that of laminating, to develop some of the most functional glassine products—protection-wise, structurally and visually. In this field, products range from unprinted glassine to attractively printed combinations of glassine to foil or glassine to synthetic films. These are being used for the packaging of such products as cake mixes, Fritos, etc.

The basic glassine-to-glassine combination utilizing microcrystalline paraffin wax, either modified or unmodified, is a product with very good grease and moistureproofness, combined with good strength characteristics. However, the strength characteristics of the two or more glassines which may be laminated are not necessarily additive. On the other hand, the pliability of laminated glassine is such that excellent operation can be had on automatic packaging equipment and, in addition, the greaseproofness and moistureproofness are less impaired when creased. This is of value in the package folds and corners produced on present automatic equipment.

The ultimate in sheet package-material protection up to the present time is afforded by glassine-aluminum foil combinations which have been produced in significant quantities in recent years and are being used for such products as chewing gum and instant coffee. These combinations supply the very best in moisture protection and in grease protection. In addition, the glassine support ply makes possible the economical use of the lightest-gage foils, which are more subject to pinholing than the costlier heavier gages. Wax laminating and solvent coating further aid in sealing pinholes. Materials packaged in this type of paper are instant coffees, powdered juice concentrates, dehydrated soups, and powdered desserts.

Soft, pliable webs result from the use of microcrystalline wax laminants, while stiffer, more rigid combinations result from the use of resin or glue dispersions as laminants. The latter supply additional grease protection, but with a sacrifice of the moistureproofness. Glassine-foil combinations may be formed into packages with glue seals or may be solvent coated to provide for heat sealing and added visual characteristics.

The end use of glassine-foil combinations dictates to a large extent whether or not the material is to be heat-seal coated and whether or not the foil ply is to be the outer package wall. For example, when the glassine-foil is to be used as a carton liner for high greaseproofness, glue seals are generally used with the glassine ply as the inner package wall. On the other hand, if the glassine-foil is to be used in a small fin-type package, heat seals are mandatory and, further, the foil ply should be the inner package wall to provide the utmost in moisture protection. In this application, the solvent coating also provides protection against any interaction between the foil and the product.

APPLICATIONS

Representative applications of converted glassines and allied paper products are listed in Table III. This list does not presume to be complete or definitive, but it is hoped that it will afford some concept of the widespread use of these packaging materials today, particularly in the food industry.

The situation is not a static one and, while some of the items listed have remained unchanged for years, as far as materials, package type, and requirements are concerned, many of the items represent an interim point in development in the direction of optimum protection at the lowest possible cost. In addition, more and more direct consumer products, particularly the nonfood industries, are turning to these low-cost protective packaging materials as a certain step to greater and more profitable markets.

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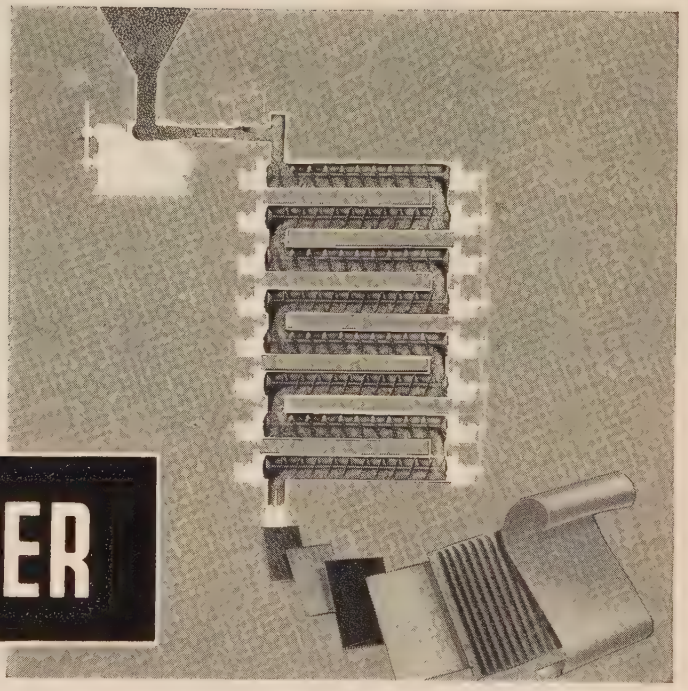
WHERE WASTE MAKES HASTE IN PULP PRODUCTION



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SULPHUR CONSERVATION IN SULPHITE PULPING

Use of Sulphur for Sulphite Pulping

TAPPI ACID PULPING COMMITTEE—
JOHN M. McEWEN, CHAIRMAN

A RECENT report by the United States Pulp Producers Association has brought out the fact that present consumption of sulphur for sulphite pulping varies from 133 to 343 pounds of sulphur per ton of pulp. At present sulphur is in very short supply so the question naturally arises, "Why can some mills make sulphite pulp with 150 or 250 pounds of sulphur per ton, while other mills require over 300 pounds per ton." The TAPPI Acid Pulping Committee has discussed this question and agreed that the following factors control the sulphur usage per ton: (1) method of calculating ratio, (2) yield of pulp, (3) relative amounts of acid and wood, (4) recovery of sulphur dioxide in relief, (5) recovery of sulphur dioxide in blow gas, (6) recovery of sulphur dioxide in blow liquor, (7) recovery of sulphur in blow liquor, and (8) efficiency of operation.

Method of Calculating Ratio

The method of calculating the expression, pounds of sulphur per ton of pulp, can vary greatly. It is believed the Pulp Producers Association figures are based on pulp as used or sold. This means some mills have sulphur consumption based on unbleached pulp, and others on bleached pulp. Individual mills may express their sulphur consumption in terms of air-dry or moisture-free pulp. Thus a mill having a 10% bleach loss might report the following sulphur consumptions: 300 pounds sulphur per air-dry bleached ton, 333 pounds sulphur per moisture-free bleached ton, or 273 pounds sulphur per air-dry unbleached ton.

Yield of Pulp

The pulp yield can greatly influence the consumption of sulphur per ton. A mill might make a high yield pulp giving a 50% unbleached yield and a 45% bleached yield. The same mill could also make a 35% yield bleached dissolving pulp. Thus exactly the same charge of chips and acid might give the following sulphur consumption: 250 pounds of sulphur per unbleached ton (high yield), 278 pounds of sulphur per bleached ton (high yield), or 357 pounds of sulphur per bleached ton (low yield).

Relative Amounts of Acid and Wood

The relative amounts of acid and wood influence the consumption of sulphur. Unless the liquor is burned, all the combined sulphur dioxide left in the digester after the side relief will be lost to the acid system. The free sulphur dioxide may be gassed off or steam stripped, but not the combined. The combined-to-wood ratio is varied by changing the combined in the acid, using more or less acid, or varying the amount of chips packed into the digester. Certain species of wood and grades of pulp permit lower combined-to-wood ratios than do others. A mill that ties up 155 pounds of sulphur per ton of pulp at a combined-to-wood ratio of 0.035 would have 200 pounds of unavailable sulphur per ton at a combined-to-wood ratio of 0.045.

Recovery of Sulphur Dioxide in Relief

All mills recover the sulphur dioxide relieved from the digester during the cook and blowdown. In some systems the gas and liquid are separated, the liquor being cooled and returned to storage tanks, while the gas is cooled and absorbed in the fresh acid by passing it countercurrent through acid tanks, recovery tower, and acid towers. The relief liquor is sometimes sent to the sewer. A more efficient and complicated system is the hot acid system where the relief is sent to pressure accumulators and the overgas passed back through the system.

The relief sulphur dioxide recovered depends on the efficiency of the recovery system and the amount of relief. Most mills relieve down to a blowing pressure of 25 to 30 pounds, however, more sulphur can be passed through the recovery system if digesters are relieved to zero pressure and washed out, or padded with steam and blown. Some mills add steam to the bottom of the digester just before blowing. This strips sulphur dioxide from the liquor so it can be recovered. The recovery of relief gas is most important because more than 500 pounds of sulphur per ton of pulp may be returned to the system by recovery of relief gas.

Recovery of Sulphur Dioxide in Blow Gas

Some mills recover the sulphur dioxide in the blow gas. This requires the installation of expensive equipment, but a maximum of about 40 pounds of sulphur per ton of pulp can be recovered by some of the most efficient systems. Many who have such systems were influenced by the fact that they help eliminate the nuisance of sulphur dioxide in the air.

Recovery of Sulphur Dioxide in Blow Liquor

It is possible to recover 25 to 30 pounds of sulphur per ton by steam stripping the sulphur dioxide from the blow liquor after it has drained from the pulp. However, this, too, requires expensive equipment, and is not normally considered unless the liquor is to be used for other purposes where the removal of the sulphur dioxide would be advantageous.

Recovery of Sulphur Blow Liquor

Combined sulphur dioxide is recovered from waste liquor only by burning the liquor and absorbing the sulphur dioxide formed in special towers. The recovery of sulphur by burning calcium-base liquor is not attractive, since much of the sulphur goes to calcium sulphate. Sulphur is now being recovered commercially from magnesium-base liquor and there is a good prospect that sulphur dioxide may be recovered from burning ammonia-base liquor. The recovery of sulphur by burning requires the installation of a means of obtaining strong liquor installation of evaporators, furnaces, and special absorption systems.

Efficiency of Operation

Some saving in sulphur may be made by more efficient operation of existing equipment. Forcing burners may lead to loss of sulphur as sublimed sulphur or sulphur trioxide. Inadequate acid tower absorption capacity may lead to high stack losses. Insufficient time to blow down digesters may lose sulphur that would normally be recovered if they could be relieved to lower pressure.

Methods of obtaining the sulphur consumption per ton of

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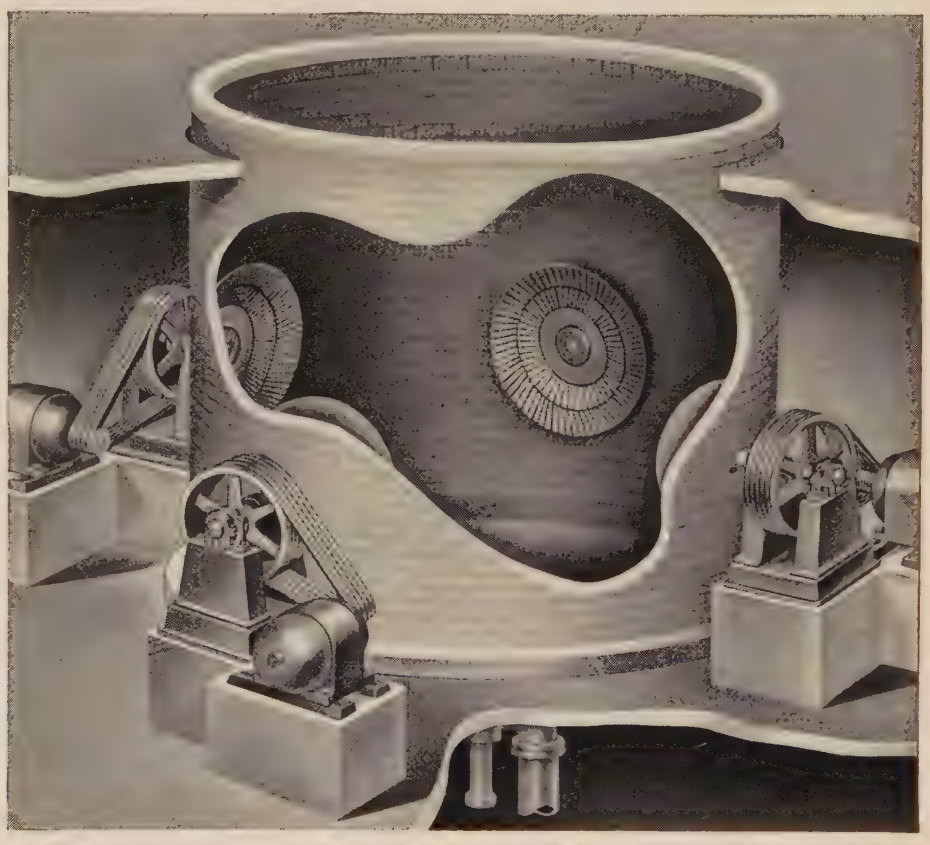

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pulp reported by the United States Pulp Producers Association are given below.

Consumption, lb. S/ton	1950 Production, tons	Means of obtaining consumption range
133–158	83,000	Burn waste liquor
200–250	783,031	Special recovery such as steam stripping and/or low combined-to-wood ratios, and/or very high yield pulps, such as mills making newsprint sulphite
251–275	612,444	High yield pulps or medium yield pulps with efficient recovery of relief and possibly blow gases
276–300	566,488	Low yield pulps with efficient recovery or high yield pulps with poor recovery
301–343	531,730	Poor recovery of relief gas or low yield pulps

Reducing Sulphur Consumption

SULPHITE COMMITTEE OF THE TECHNICAL SECTION, CANADIAN PULP AND PAPER ASSOCIATION

This report deals with a study of operating practices in ten representative mills where sulphur consumption is below the average of the industry as a whole. Examples of proven procedures are given. Sources of possible sulphur savings, discussed in the report, are summarized in the probable order of importance, as follows:

A. Maximum gas recovery through reduction of pressure before blowing.
B. Maximum recovery of acid by means of side relief.
C. Changes in cooking practice
   I. Lower combined sulphur dioxide
   II. Chip packing
   III. Forced circulation
   IV. Presteaming
   V. Higher free sulphur dioxide.
D. Acid plant operation
   I. Sulphur storing and handling
   II. Increased burner efficiency
   III. Decreasing tower losses
   IV. Reduction of sulphur trioxide formation.
E. Increased yield of pulp from wood.

Realizing the necessity for sulphur conservation because of an indicated reduction in supply, the Sulphite Committee of the Technical Section, Canadian Pulp and Paper Association, has undertaken a study of sulphur consumption in sulphite pulp mills. This preliminary report emphasizes the practices which it is considered will reduce the overall sulphur consumption in the sulphite industry. Because of the urgency of the situation, the committee decided to collect details of operating practice only from mills whose sulphur consumption was below the average of the industry as a whole. This report, based upon the information obtained from ten representative mills, makes several recommendations for procedures which are applicable to present standard equipment and which have proved in practice to give reductions in sulphur consumption. The investigation has been of sufficient scope that every mill can apply some of the recommended practices to advantage.

The sulphite pulp industry in Canada has consumed in a recent period of approximately 1 year an average of 272 pounds of sulphur per air-dry ton of pulp produced. Some mills are using in the order of 200 pounds per ton or less, while others require over 300 pounds per ton. These figures do not take into consideration the wood used, the variation in yields of unbleached pulps, nor the shrinkages in the manufacture of various grades of bleached pulps. Because of this, and because of limitations of equipment presently installed, it is realized that all mills cannot operate in the lower ranges of sulphur requirements. But this study has revealed that many mills can make substantial savings. The theoretical sulphur required to produce 1 ton of pulp at a yield of about 46% is approximately 170 pounds. The eventual goal of the industry should be to approach this figure.

The cooking of wood to produce sulphite pulp, under present practice, requires an enormous excess of sulphur in the original digester charge. This amounts to approximately 700 pounds per ton of unbleached pulp having a yield of 46%. The greatest economy can be made in reclaiming that part of this charge not used up in cooking. In addition, various changes in cooking practice may alter the amount of sulphur in the charge and thus result in a further saving of sulphur. The details of acid manufacture require constant attention in order to prevent losses which may add up to appreciable sulphur equivalents. Recovery of sulphur from blow gases and the stripping of sulphur dioxide from waste liquor must also be given serious consideration, but is outside the scope of this preliminary report. In the following paragraphs the committee makes various suggestions for more efficient operations based upon known experience in the mills investigated. These, insofar as is possible, are recorded in order of importance.

A. Maximum Gas Recovery Through Reduction of Pressure Before Blowing

All mills in the survey have stressed the importance of recovering as much gas as possible before blowing. One mill, where increases in the amount of side relief were made at the same time, reported a reduction in sulphur from 280 pounds per ton to 240 pounds per ton with a change from 35 to 25 pounds gage in the digester pressure at the blow. This same mill lowered the blowing pressure still further to 20 pounds gage and the sulphur was reduced to 200 pounds per ton.

Another mill continued to pull down the pressure until the gas showed a content of 25% sulphur dioxide. This practice resulted in a sulphur drop of 30 pounds per ton or from 230 to 200 pounds.

An old example cited showed that a drop in blowing pressure from 60 to 40 pounds gage resulted in a sulphur saving of 20 pounds per ton. This same company, using the laboratory digester, found that the sulphur recovered in dropping from 30 to 0 pounds gage was equivalent to approximately 30 pounds per ton of pulp produced.

Efficient gas recovery before blowing depends upon factors that many mills may not be able to alter. In the first place, the relieved gas must be absorbed, and mills reporting the lowest pressures with the greatest improvement in sulphur usage have installed multistage, countercurrent, pressure recovery systems. Secondly, the minimum pressure necessary for blowing may be quite high in many mills. Certain cases have been reported where steam was used to boost the blowing pressure with a detrimental effect on pulp quality. Other cases report using steam regularly and one mill has reduced the sulphur consumption from 212 to 204 pounds per ton by steam stripping during the blowdown. The reports indicated that the method of distributing steam during the blowdown was most important and that this may have been the cause of the conflicting accounts regarding pulp quality. It is considered by some that the introduction of steam at the top of the digester is preferable.

B. Maximum Recovery of Acid by Means of Side Relief

A large volume of acid in the original digester charge is required in order to cover the chips. Subsequently, some of it is recovered by means of the side relief. One mill reports a saving of 30 pounds of sulphur per ton by increasing the volume of side relief by 2000 gallons while at the same time moving ahead the commencement of the relief by $1^1/_2$ hours. There is also the example cited under maximum gas recovery where, in conjunction with lowered blowing pressure, the sulphur dropped from 280 to 240 pounds per ton.

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The amount of side relief that may be removed from the digester will depend upon several factors including the size of low-pressure relief lines. With a good recovery system and *efficient* use of eductors the digester blowdown period can be reduced. One mill reports a blowdown period of 1 hour, reducing pressure from 70 pounds gage to atmospheric. Generally speaking, the greater the volume taken the greater will be the recovery of sulphur. On the other hand, because of its lowered content of sulphur dioxide, acid from the side relief will dilute the cooking acid in storage. Therefore, an increased volume of side relief must be complemented by increased recovery of sulphur dixoide or the production of a stronger acid in the acid plant. The effect of dilution can be countered to some extent by commencing the relief earlier in the cook when it is stronger, but one must be certain that penetration has been effected; otherwise many chips will have burned centers. Nevertheless, the reports showed that sulphur consumption could be improved through a more efficient recovery of side relief.

The practice of removing approximately 1000 gallons of side relief prior to the start of the cook results in considerable sulphur savings since this relief is in the form of strong acid. In this regard, the most common practice is to pump up to 75 pounds gage pressure in the digester with the accumulator pump. As soon as the pump is shut down, the side relief valve is opened and digester pressure dropped to within 10 pounds of high pressure accumulator pressure. In order to insure sufficient acid penetration, the acid is circulated from the accumulator to the digester and back to the accumulator for a period of at least fifteen minutes, depending on local conditions. This precirculation period sometimes is as long as 2 hours.

C. *Changes in Cooking Practice*

I. Lower Combined Sulphur Dioxide. Sulphur consumption is very largely determined by the amount of sulphur which is present in the cooking acid as calcium bisulphite. Apart from that removed in the side relief, none is at present recovered. Amounts of combined sulphur dioxide in excess of that required for cooking are reported to have an effect on pulp quality and for this reason may not be reduced. Where possible, an attempt to lower the combined is suggested. One mill reports a sulphur reduction of 35 pounds per ton by this means. Another mill reported that a lowering of combined sulphur dioxide to 1.15% did not affect quality as expected. This was contrary to previous experience in that mill.

Large amounts of combined sulphur dioxide present in the acid during the blowdown period are reported to hinder the recovery of gas. Thus, there is a relationship between excess combined and the amount of gas that can be recovered before blowing.

Insufficient combined sulphur dioxide results in burned cooks and therefore care must be exercised when reducing the amount available. The ratio of acid to wood will vary over quite large ranges from mill to mill depending upon the packing techniques employed. Where more wood is charged to a digester, the concentration of combined sulphur dioxide in the acid must be greater. A good guide is that the combined sulphur dioxide in the acid available for cooking (as calculated by the Palmrose method or any similar method which records the result as calcium monosulphite) should be about 5% by weight of the oven-dry wood. One operator comments that the minimum amount of combined consistent with the grade of pulp being produced should be used. He adds that 5% of combined based on oven-dry wood is a maximum figure and that in most cases the combined should be between 3.75 and 4.5% based on the oven-dry wood.

II. Chip Packing. An indirect result of chip packing appears to be a reduction in sulphur consumption. One mill reports a reduction in sulphur of 20 pounds per ton where the tons per cook increased from 10.5 to 12.0 tons. Another mill where packing was employed also reported a sulphur decrease of 20 pounds per ton, but qualified it by showing an increased blowdown during the same period. Nevertheless, the study showed that increased packing decreased the acid-to-wood ratio. This may have reduced the per cent of combined sulphur dioxide based on the wood and thus reduced the sulphur consumption. Packing to the extent of approximately 12.5 pounds of oven-dry wood per cubic foot of digester space with wood of 0.420 density was reported. This mill, however, also reported having excellent forced circulation during cooking. It is obvious that a higher wood-to-liquor ratio reduces the volume of waste liquor per ton of pulp and hence the sulphur consumption.

III. Forced Circulation. In addition to the effect stated in the preceding paragraph where forced circulation was necessary with maximum chip packing, it was reported that better and more uniform penetration brought about by forced circulation resulted in lower rejects and a higher screened yield. This in turn reduced the sulphur per ton of acceptable pulp.

The effect of side relief on sulphur consumption has been discussed in previous paragraphs, but there is a relationship between increased amounts of side relief and forced circulation which can be mentioned here. Once penetration is assured, varying amounts of side relief that will bring the liquid level below the top of the chips may be taken provided there is forced circulation of the acid. There will be no detrimental effect on pulp quality so long as the exposed chips are being continually wetted.

IV. Presteaming. This alteration in cooking practice may be used for two reasons. In the first place it may be for the sole purpose of increasing the chip packing. Several mills have reported this practice and the indirect effect on reducing sulphur consumption through packing has already been discussed.

Presteaming may also be practiced as a means for bringing about more rapid penetration of the chips by the cooking acid. This enables a more rapid rise to temperature and, in a fixed cycle allows a longer blowdown period. Three mills report using this practice, and others are known to use it—with no detrimental effects on pulp quality. The more rapid penetration allows a more efficient recovery of side relief. The relief can be started earlier and more can be removed provided the per cent combined sulphur dioxide on the wood does not drop below the danger point. No figures showing decreases in sulphur consumption which could be attributed to increased side relief through presteaming have been reported. The effect on sulphur consumption is now under study by several mills employing this practice.

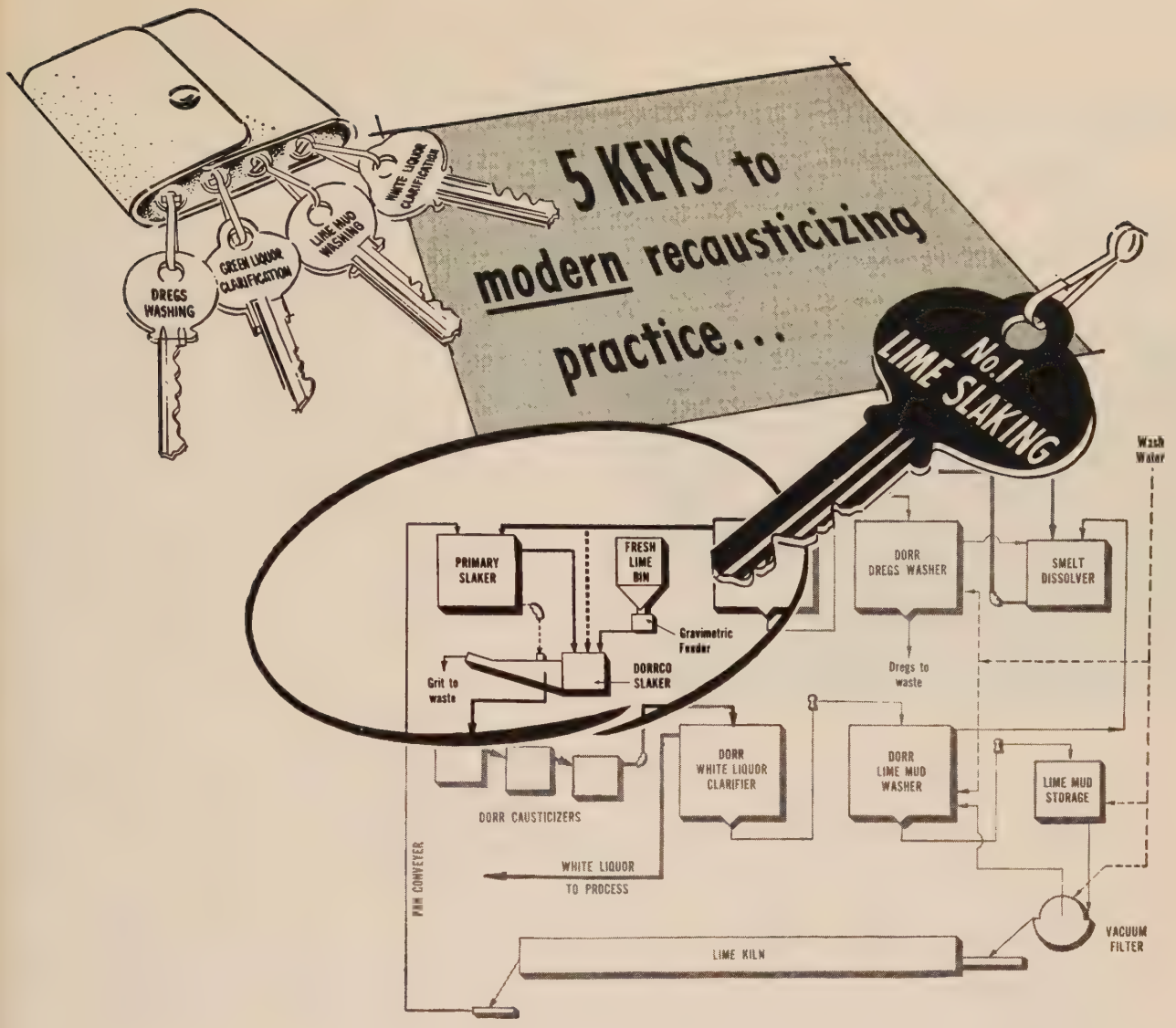
One mill has added the additional steps beyond steaming that are required for the method developed at the Pulp and Paper Research Institute of Canada. In this method, at present confidential to licensees, the resultant rapid penetration has allowed decrease of the free sulphur dioxide in the cooking acid. This is a decided advantage where cycles do not allow time for efficient blowdown with present equipment.

It should be emphasized that presteaming can greatly increase the chip charge and should not be practiced to its full extent in digesters not equipped with forced circulation.

V. Higher Free Sulphur Dioxide. A high free sulphur dioxide gives the effect of more rapid penetration and thus allows a more rapid temperature rise. Thus the side relief may be taken earlier and this practice has been reported in some cases. However, a larger amount of free sulphur dioxide requires a more efficient recovery system. Otherwise there will be no net sulphur saving.

D. *Acid Plant Operation*

In acid manufacture no large savings were reported except



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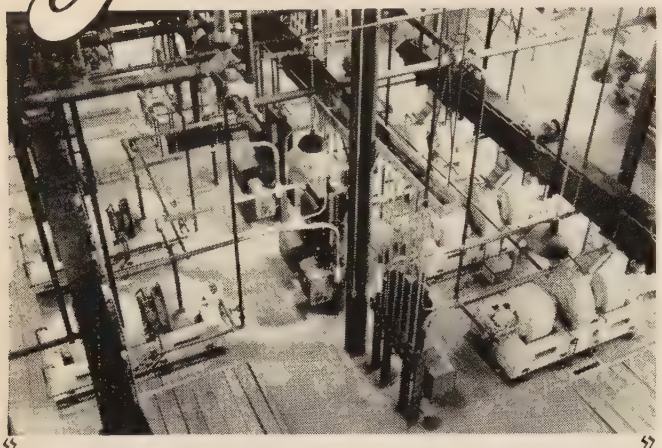

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that all mills placed emphasis on sulphur storage and handling. Two mills reported losses of 5 and 3%, respectively, through wastage in unprotected storage piles, and all recommended care in weighing and handling with frequent checks of the scales.

In acid making a uniformly high content of sulphur dioxide in the burner gas makes for efficient operation. Several mills reported that the installation of automatic level controllers for controlling the level of sulphur in the burners has resulted in more uniform operation with the sulphur dioxide content at a high level. One mill reported that, in addition, automatic regulation of the air dampers between the burner and combustion chamber has been installed resulting in increased efficiency of operation. One operator also recommends the use of recording thermometers in the combustion chamber and a recording sulphur dioxide analyzer, in order to maintain maximum acid plant efficiency.

In the production of sulphur dioxide from sulphur the formation of sulphur trioxide apart from any effect on the subsequent pulping reaction, is a direct loss of sulphur. The increased efficiency of operation of the sulphur burner, mentioned in the preceding paragraph, will have a beneficial effect on reducing the formation of sulphur trioxide. Other danger spots are the combustion chambers and coolers. Leaks in either can result in large sulphur losses through the formation of sulphur trioxide.

The vent from the absorption towers can be a further source of sulphur loss. One mill reports losses as high as 4% from the towers. This can be reduced to a minimum by regular checking and daily checks are recommended. Since such losses can fluctuate considerably because of the varying amounts of low pressure relief returned through the recovery systems, it is recommended that either a recording sulphur dioxide analyzer be installed or hourly checks be made for a period of a few days in order to determine the variation in these losses.

Elimination of all losses from the weak tower is important, particularly in summertime when the temperature of make-up water is high. Uniformity of water temperatures in the towers and careful control over acid plant operation are essential.

E. Increased Yield of Pulp from Wood

This factor has been left to the last although it may with development, and in time, prove the largest single factor in reducing sulphur consumption. High yield sulphite is commonly associated with elaborate refining equipment—and, as such, is not properly a part of this study. However, where pulp quality will allow, every effort should be made to increase the yield of pulp from wood. As an example, assuming a present sulphur consumption of 235 pounds per ton with a yield of 45%, an increase of 5% in the yield will reduce the sulphur to 212 pounds per ton.

CONCLUSION

In conclusion, this study has emphasized the fact that sulphur reductions are possible in many mills, and the committee recommends that attention to detail is most important since appreciable reductions will occur, in most cases, only as a result of the sum of several small savings.

Finally, mills are requested to give attention to measuring devices in order that any savings can be properly credited. This will apply not only to sulphur measurements, but to the pulp as well.

It is recognized that benefits other than sulphur reduction can result from some of the practices outlined in this report. These may include reduction in steam consumption, reduced tailings, higher yields, and more uniform pulp quality.

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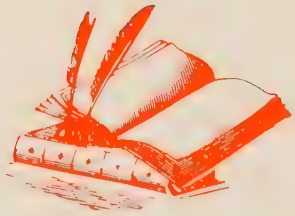

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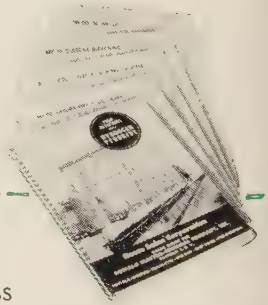

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Hydrogen Peroxide Bleaching of Chemical and Mechanical Pulps

New Developments and Process Applications

R. L. McEWEN, F. R. SHELDON, and D. H. NELSON

Disclosure of new developments in the hydrogen peroxide bleaching of chemical and mechanical pulps is made with particular reference to sulphites and krafts. Improved process applications permitting greater bleaching efficiency are presented. New high density peroxide methods described include the continuous moderate temperature system for pulp crumbs and the semicontinuous cold steep bleaching process for crumbs, continuous webs, and cut sheets. The mixed peroxide (H_2O_2 and Na_2O_2) chemical system for bleaching is discussed, and data are presented which establish its high commercial efficiency. Commercial and laboratory results on various peroxide processes are presented. Data are given on sulphite pulp bleaching in a single stage and as one stage in a multistage system, on kraft pulp alkaline peroxide extraction, and on kraft pulp bleaching and superbleaching. On chemical pulps, at high brightness levels, minimum cellulose degradation resulting from selected peroxide bleaching methods is contrasted with excessive fiber damage often obtained with conventional chlorine methods. Data are also presented on the peroxide bleaching of semichemicals, chemigroundwoods, and groundwoods of various wood species. The bleaching of agricultural residues and flax pulp is also discussed.

THE paper industry has become familiar with peroxide bleaching through contact with groundwood bleaching processes and the numerous technical publications dealing with these processes. Broad surveys covering the information on groundwood may be found in the literature (*1*, *2*) and additional new references are cited herewith (*3–23*).

Bleaching applications of peroxide to chemical pulps have been under superficial study for numerous years. Published research to Nov., 1950 (*24–40*), dealt largely with the use of peroxide as one stage in a multistage system using chlorine and/or reducing agents. While results were of academic interest, few applications were made to chemical pulp bleaching operations on a commercial scale.

It is our intention to deal mainly with new, practical developments and process applications of peroxide to chemical pulp types and to discuss herein only the most recent advancements in the peroxide bleaching of groundwood and related papermaking fibers. Due to changing chemical markets, pulp and paper yield requirements, and conservation of pulpwood supplies, interest in peroxide bleaching is great. The new, commercially sound developments outlined below are expected to result in even more widespread acceptance of hydrogen peroxide as a bleaching agent for all types of pulps.

R. L. McEWEN, F. R. SHELDON, and D. H. NELSON, Research and Development Div., Buffalo Electro-Chemical Co., Inc., Buffalo, N. Y.

PROCESS TYPES

Peroxide bleaching may be carried out in a number of different ways depending on the nature of the pulp, available equipment, capital investment, and chemical process limitations. The choice of process requires a balance between these factors and bleaching efficiency in terms of brightness gain per chemical dollar. Chemical process limitations relate to the bleaching variables (i.e., time, temperature, density, alkalinity, and hydrogen peroxide percentage) and their interrelationships.

As primary interest is in obtaining the highest return per chemical dollar, most recent research and development efforts have been directed toward moderate or high density systems employing low cost equipment, and equipment which perhaps may permit another function while bleaching progresses. In addition, studies have been undertaken to permit economical operation in small as well as large mills.

To avoid confusion, arbitrary classification of various processes according to density has been made for this report as follows: (1) low density (3–6%), (2) moderate density (10–15%), and (3) high density (20–50%). These classifications apply to batch, semicontinuous, or continuous operation.

Low density systems are generally those having a 3 to 5-hour retention period at temperatures in the range of 30 to 50°C. Since available or low cost equipment is involved, most small mills have adopted these systems, largely for batch operation.

Moderate density systems are of the continuous type, requiring about 2 to 5 hours' retention time at 40 to 60°C. Chemical pulps require longer times and higher temperatures than do mechanical pulps. New developments in the moderate density process field relate primarily to equipment changes whereby lower cost thickening, mixing, and tower equipment is being used. Beyond this, however, no basic changes have developed in the past two years.

Greatest progress has been made in the field of *high density* operation. These densities require bleaching times of $^3/_4$ to $1^1/_2$ hours at 40 to 60°C. for groundwood, 1 to 3 hours at 50 to 70°C. for chemical pulp, or one half to several days' holding time at ambient temperatures for both pulps.

Continuous high density operation consists of thickening pulp by deckering, passing through a screw press, blending of pulp with alkaline peroxide liquor in a disk-type mixer, followed by suitable retention in a con-

tinuous tower. The crumbs are removed by a screw, diluted, neutralized, and pumped to bleached pulp storage (see Fig. 1). This system is in commercial operation on groundwood, and its utilization for semi-chemical and chemical pulps should produce excellent bleaching efficiencies.

The newest high density process development to come into commercial use is called the *cold steep bleaching process* (*4*, *14*). It has been designed primarily for small capacity mills, for those having feltless wet machines, or for those shipping their product to another mill. In the steeping process, mechanical or chemical pulps (or mixtures of the two) are thickened to densities of about 40 to 50%. Alkaline peroxide bleach liquors of controlled alkalinity are applied continuously and the pulp allowed to stand in roll, lap, or crumb form at existing temperatures for 1 to 5 or more days during which time the pulp is brightened. The bleached pulp is thereafter added to paper furnishing equipment, only minor pH adjustments being necessary for steep bleached chemical pulps. Color stability is good for reasonable storage or shipping periods (Fig. 2). The process is used on pulp lap from Kamyr machines (Figs. 3 and 4), as well as on pulp crumbs produced by a screw press dewatering device (Fig. 5).

Mill development is well under way for using impregnating equipment to apply cold steep bleach liquors to chemical pulps at the receiving mill. Cut pulp sheets fed to the impregnator are saturated with bleach liquor, and stacked on skids for storage at mill temperatures (Fig. 6).

Cold steep bleaching efficiency and physical qualities of pulps produced by the process are the best achieved by any known single-stage system. Such results are due primarily to the high densities and mild temperatures employed. Commercial use of the steeping process has been with groundwoods, sulphites, and mixtures of the two. Extensive laboratory studies have been made on most other pulp types. In some mills, cost of chemical handling equipment is the only added investment needed to produce cold steep bleached pulps on a commercial scale. In others, dewatering equipment or a sheet impregnator are required.

The chemicals used in the above systems differ very little from those previously disclosed in the literature (*1*, *2*).

The *mixed peroxide system* is a new chemical process which has been in use for about three years. Developed by the Buffalo Electro-Chemical Co., Inc., the mixed peroxide system is in successful commercial operation in six mills. The system is so called because hydrogen peroxide and sodium peroxide are used together in preparing the alkaline peroxide bleach liquor. The mixed system may be applied to most all peroxide bleaching processes for all pulp types. Ratios of hydrogen peroxide to sodium peroxide are determined by the free caustic alkalinity desired for bleaching a particular pulp type at a given density. The system

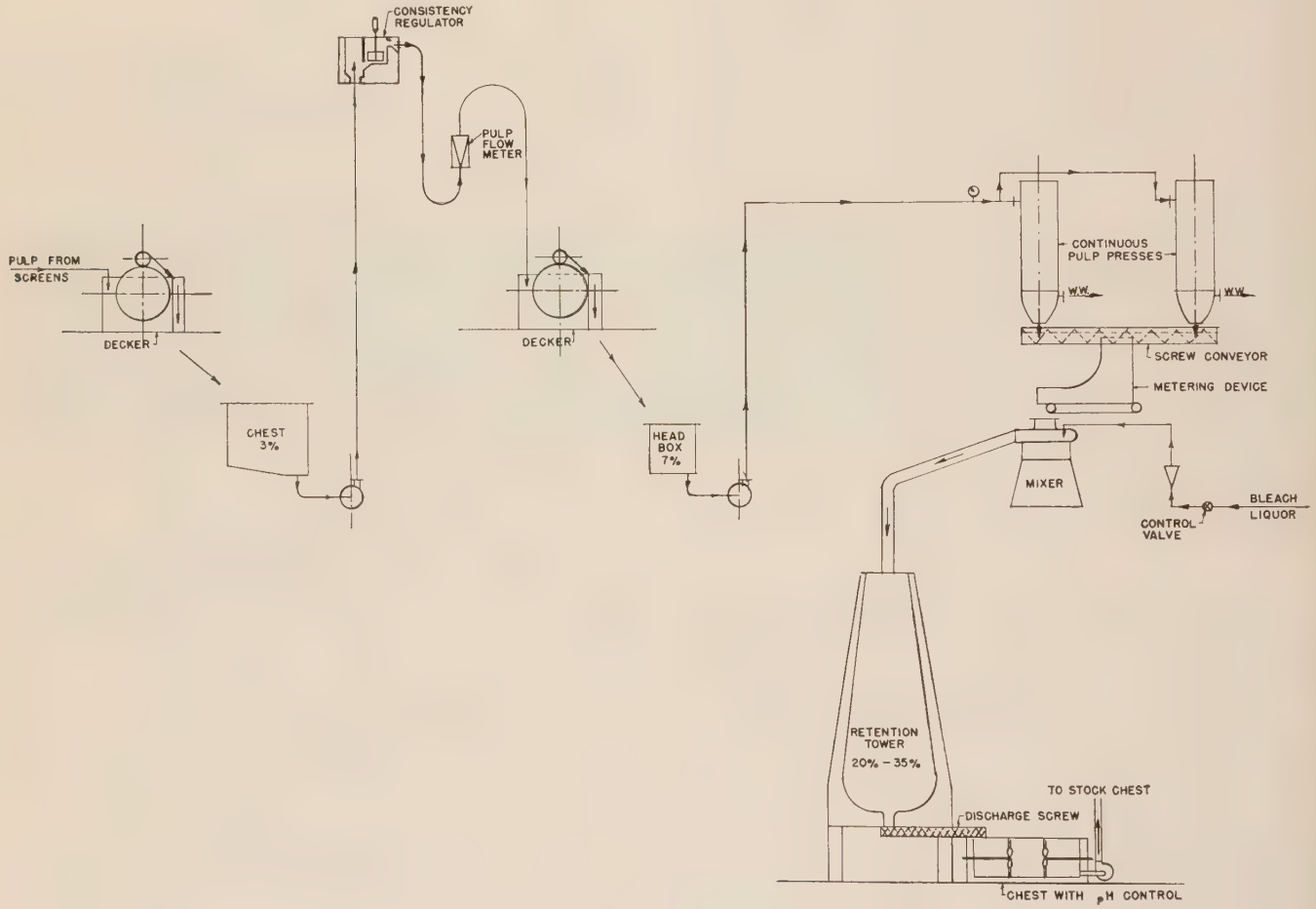

Fig. 1. Continuous high density bleaching system

Table I. Mill Performance Data for Two Peroxide Systems

	Mill A		Mill B		Mill C	
	H_2O_2 + Na_2O_2 system	Na_2O_2 + H_2SO_4 system	H_2O_2 + Na_2O_2 system	Na_2O_2 + H_2SO_4 system	H_2O_2 + Na_2O_2 system	Na_2O_2 + H_2SO_4 system
Av. % active O_2, moisture-free pulp basis	0.375	0.422	0.350	0.350	0.300	0.300
Av. pulp brightness increment	9.8	9.6	7.5	6.8	10.2	8.6
Chemical cost, $ per moisture-free ton	8.65	9.09	8.11	7.35	7.36	6.96
Cost in $/point brightness/ moisture-free ton	0.88	0.95	1.08	1.08	0.72	0.81

obviates the need for using caustic soda with hydrogen peroxide, or sulphuric acid with sodium peroxide. Extensive analysis of its performance by mill personnel has established the fact that the mixed peroxide system

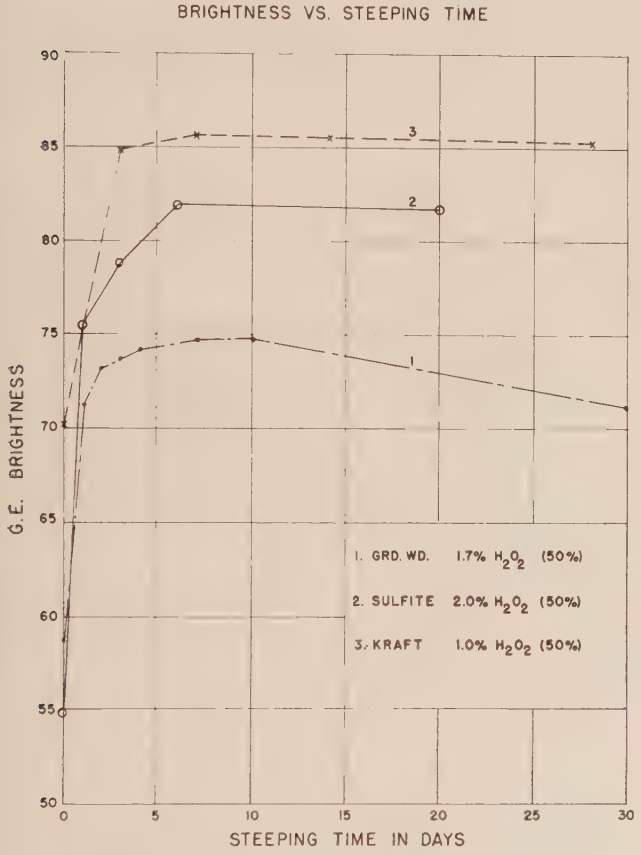

Fig. 2. Effect of time on cold steep bleach brightness

produces, at equivalent or lower chemical costs, results equal to those obtained with sodium peroxide and sulphuric acid (see Table I). An explanation of these results lies in improved peroxide stabilities and attendant active oxygen savings. At the same time, hazardous acid handling and possible iron contamination are eliminated, and trouble-free operation results.

APPLICATIONS TO PULP TYPES

Generalizations on the benefits obtained with hydrogen peroxide systems are difficult. Pulp properties are determined largely by empirical methods and are dependent on wood type, pulping method and conditions, fiber purity, and the bleaching operation itself. As is so often the case in the paper industry, because of the above factors, each bleaching operation is an almost unique problem requiring individual study.

We can generalize to the extent that bleaching with hydrogen peroxide gives high yields and improved brightness and aging characteristics. In addition, due perhaps to the fact that all peroxide bleaches are alkaline, peroxide bleached chemical pulps often hydrate more easily. Chemical pulps as a class may be bleached to the 80 brightness level, or peroxide superbleached to the 85 to 90 levels without fiber degradation. When subjected to high drying temperatures during papermaking, these hydrogen peroxide bleached pulps very often show improved brightness stability compared with chlorine treated pulps. For this reason it is felt that peroxide should be applied in the last stage of any multistage bleaching system.

The purpose in using hydrogen peroxide (and related peroxygen compounds such as peracetic acid) for bleaching chemical pulps is to eliminate or at least minimize the cellulose degradation that occurs with the usual chlorine bleaching techniques. This is of particular interest in the high brightness range of 80 to 90 where the ratio of cellulose to noncellulosic constituents is high. Since in this range the cellulosic component is relatively unprotected, fiber damage can readily occur except under the mildest conditions.

Reference to the oxidation potentials for peroxide, chlorite, and hypochlorite indicates that the peroxide oxidation potential is the lowest of the three and, therefore, should be expected to give the least degradation (Fig. 7).

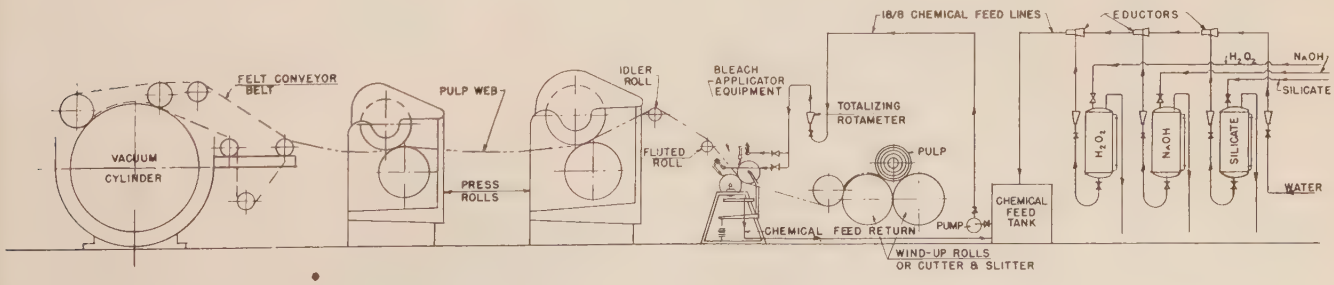

Fig. 3. Cold steep bleaching of a continuous pulp web

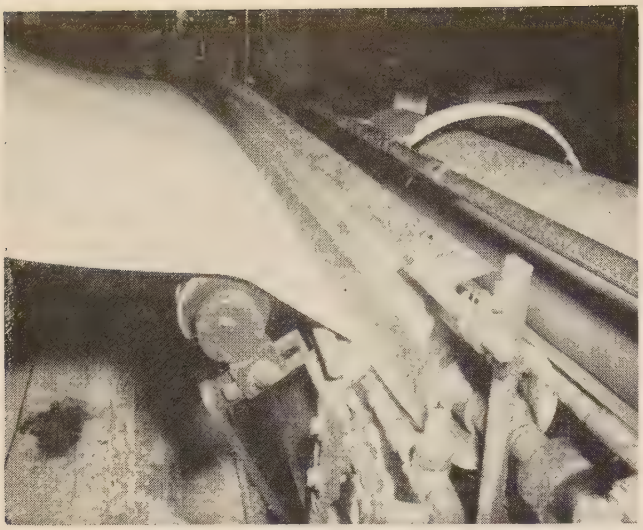

Fig. 4. Commercial cold steep operation on Kamyr machine

Examples of particular hydrogen peroxide applications to various pulps will illustrate the above-mentioned points and will compare efficiencies of newly disclosed processes with those of former bleaching techniques.

Sulphite

Hydrogen peroxide may be used to bleach sulphite pulp in a single stage, or as a part of a multiple process using chlorine and/or hypochlorite in the early stages. As with other pulps, factors influencing bleach response are time, temperature, density, and, of course, amount of peroxide used. In addition, as would be expected, pulp bleachability as measured by permanganate number is also of importance. Increments obtained with a given amount of peroxide are usually smaller with higher permanganate numbers. Response is also decreased as original brightnesses rise.

Single-Stage Treatments: Single-stage bleaching with peroxide is most efficiently carried out with peroxide at moderate to high density. Improvement in brightness response by increasing density is shown in Fig. 8. This figure also indicates the difference in response caused by different permanganate numbers and shows

Table II. Cold Steep Bleaching of Unbleached Sulphite

$KMnO_4$ no.	% H_2O_2 50%	Bleaching density, %	Brightness	
			Original	Final
6.8	1.0	34.2	61.8	82.5
6.8	1.5	33.6	61.8	84.1
10.0	0.6	25.0	61.3	71.6
11.7	1.0	34.4	55.5	78.3
11.7	1.2	35.0	55.5	81.0
11.7	1.8	35.0	55.5	82.8
11.7	2.0	34.0	55.5	83.9
12.6	1.0	33.6	57.0	75.3
12.6	2.0	33.8	57.0	78.9
13.2	1.0	27.8	55.1	77.3
13.2	2.0	27.5	55.1	82.0
13.4	1.0	62.0	58.1	71.3
13.4	1.5	62.0	58.1	74.7
13.4	2.0	62.0	58.1	79.6
13.9	1.0	35.0	56.0	74.5
13.9	1.2	35.0	56.0	76.3
13.9	1.5	35.1	56.0	77.2
13.9	1.8	35.0	56.0	81.4
15.0	1.0	32.9	58.2	72.1
15.0	2.0	32.6	58.2	77.6
20.5	2.0	26.4	50.8	72.6
20.9	2.0	29.7	49.3	72.6
21.6	1.6	25.0	62.8	74.6

Table III. Comparison of Cold Steep Bleaching and Other Bleaching Methods for Unbleached Sulphite

$KMnO_4$ no.	% H_2O_2 50%	Bleaching density, %	Temperature, °C.[a]	Brightness		Viscosity	
				Original	Final	Original	Final
6.8	2.0	34.2	R.T	61.8	85.6	61	62
10.0	1.6	25.0	R.T.	61.3	79.9	81	87
10.0	4% av. Cl_2	25.0	R.T.	61.3	79.8	81	26
12.6	2.0	33.8	R.T.	57.0	78.9	100	98
12.7	2.0	5.0	50	54.0	67.6	...	...
12.7	2.0	13.0	50	54.0	71.1	...	...
12.7	2.0	31.5	R.T.	54.0	79.5	...	...
18.5	1.0	34.5	R.T.	46.4	62.8	38	40
18.5	1.5	32.5	R.T.	46.4	69.3	38	44
18.5	2.0	35.9	R.T.	46.4	73.9	38	42
19.8	2.0	30.0	R.T.	57.0	81.9	86	89
20.9	3.0	30.9	R.T.	49.3	75.7	111	120
20.9	3.0	37.0	50	54.9	74.2	111	103
20.9	3.0	33.2	100	52.7	70.2	111	90

[a] R.T. = cold steep at room temperature.

the gain in brightness obtained by increasing peroxide percentage. Single-stage formulas (moisture-free pulp basis) generally employ 1.0 to 2.0% hydrogen peroxide 50%, 4 to 6% sodium silicate, and 0.50 to 1.5% sodium hydroxide.

In single-stage bleaching of unbleached sulphite with peroxide, by far the most interesting brightness gains are obtained at high density using the new cold steeping process. The process not only permits achievement of high brightness in a single stage, but also causes no fiber degradation as measured by the standard cuprammonium viscosity test. In addition, there is evidence that pulp hydration times are shortened. Data on the application of steep bleaching to various unbleached pulps may be found in Tables II and III. The latter table includes results of viscosity measurements and comparisons of maximum brightnesses obtained with other bleaching methods.

When the data of Table II are subjected to statistical analysis (*22*) for determining the correlation between brightness response (ΔB) and the several independent variables, most significant of these variables are found to be peroxide percentage, permanganate number, and original pulp brightness. Correlation analysis of more

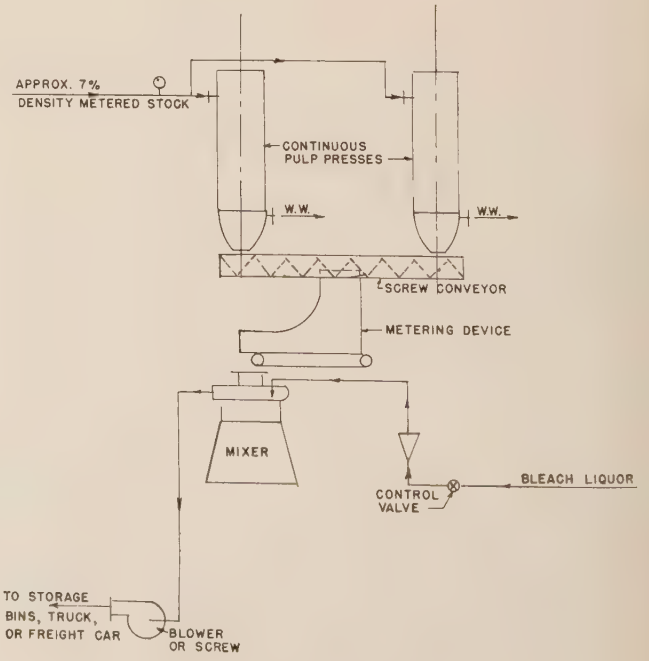

Fig. 5. Cold steep bleaching of pulp crumbs

Table IV. Hydrogen Peroxide Treatments as the Final Stage of Sulphite Bleaching

% H_2O_2 50%	Bleaching density, %	Temperature, °C.[a]	Brightness Original	Brightness Final	Viscosity Original	Viscosity Final
1.10	5.0	60	53.8[b]	78.5	..	..
1.10	8.0	60	53.8[b]	78.8	..	..
1.10	12.0	60	53.8[b]	80.4	..	..
1.40	15.0	60	53.4[b]	80.1	68	64
1.3% av. Cl_2	5.0	35	53.4[b]	80.2	68	56
0.65% av. Cl_2 then	5.0	35				
0.65% H_2O_2	15.0	60	53.4[b]	81.1	68	68
1.5	32.0	R.T.	73.1	85.1	35	39
1.5	12.0	55	73.1	84.6	35	33
1% av. Cl_2	5.0	40	73.1	79.2	35	23
1.0	30.0	R.T.	75.5	90.0	43	49
1% av. Cl_2	5.0	35	75.5	85.4	43	24
1.00	32.7	R.T.	72.7	90.1	63	66
0.50	34.5	R.T.	69.8	85.1	..	..
0.75	34.8	R.T.	69.8	86.5	..	..
1.00	34.5	R.T.	69.8	87.5	72	80
0.25	33.8	R.T.	88.3	93.2	..	..
0.75	34.3	R.T.	88.3	94.2	40	40
0.25	35.0	R.T.	86.7	92.9	..	..
0.75	33.9	R.T.	86.7	93.5	45	56
1.00	30.0	R.T.	71.5	88.6	52	58

[a] R.T. = cold steep at room temperature.
[b] Chlorinated and caustic extracted pulps, others semibleached.

extensive data than appear in the table resulted in a working equation which allows, within relatively narrow limits, prediction of brightness increments. It is thus possible to predict final brightnesses achievable with the cold steeping process on almost any given unbleached sulphite pulp.

The steeping process has been applied commercially to unbleached sulphite produced on a standard Kamyr machine. In one case, pulp of 9 permanganate number at 59 brightness was bleached to 80 to 83 within a 10-day period by using from 1.5 to 1.8% hydrogen peroxide 50%. Pulp strengths were unaffected by bleaching, and with steep bleached pulp as the furnish, paper machine operation was normal.

Multistage Treatments: As a part of multistage bleaching of unbleached sulphite, hydrogen peroxide treatments are best employed in final stages. Here again, the higher densities are more efficient and the cold steeping process especially permits very high brightnesses without appreciable loss in fiber strength.

At low and moderate densities, bleach response to peroxide is greatly enhanced by pretreating the unbleached pulp with hypochlorous acid. This newly developed, controlled pretreatment is of short duration and is followed directly by application of the peroxide liquors. No intermediate washing step is required.

Normal peroxide formulas for unbleached pulps are used. Figure 9 shows the results of a 2% hydrogen peroxide 50% bleach following pretreatments with various amounts of available chlorine as HOCl. In a typical commercial application at low density, an average final brightness of 71.2 with 1.7% hydrogen peroxide 50% in a single stage has been regularly increased to 75.0 by pretreating with 3% available

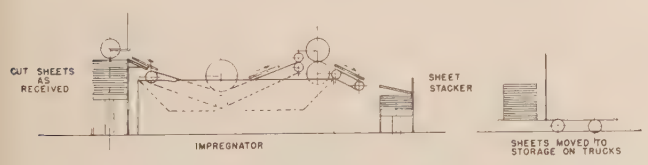

Fig. 6. Cold steep bleaching of cut pulp sheets

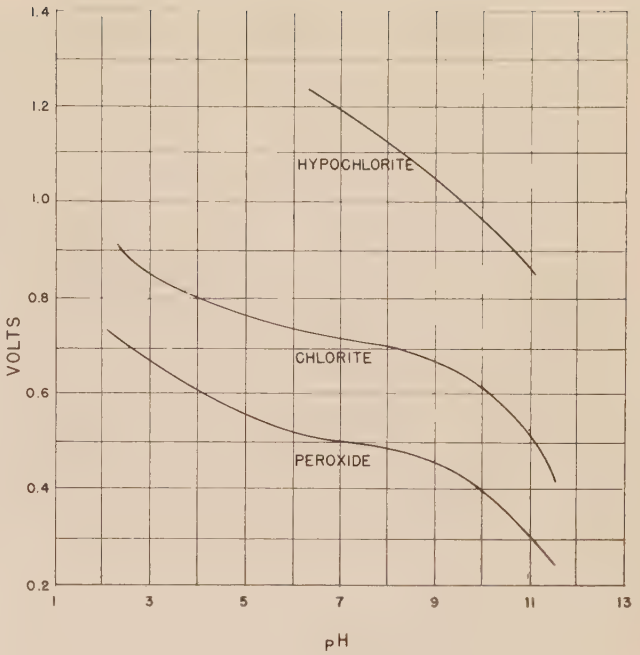

Fig. 7. Oxidation potentials

chlorine as hypochlorous acid followed by only 0.85% hydrogen peroxide 50%.

For last-stage bleaching of hypochlorite treated or chlorinated and caustic extracted pulps about 0.3 to 1.5% hydrogen peroxide 50%, 2.5 to 3.0% sodium silicate, and 1.0 to 1.3% sodium hydroxide may be used. For cold steep "superbleaching" of semibleached sulphites 0.5 to 1.5% hydrogen peroxide 50%, 3 to 5% sodium silicate, and 0.5 to 1.5% sodium hydroxide are normally used. Table IV presents data obtained when hydrogen peroxide was employed in the last stage of a bleaching process or, as with the cold steeping method, in a separate treatment on semibleached pulp. Cuprammonium viscosities and comparisons with last-stage chlorine treatments are included in this table.

The properties of peroxide bleached sulphites are equivalent to or better than those now normally obtained with other bleaching methods. Table V presents the results of laboratory beater studies on a sulphite pulp given various peroxide treatments and on the same pulp which was mill bleached in a two-stage chlorine-hypochlorite process. Data are also included for similar tests on pulp bleached commercially by the cold steeping method.

Table V. Physical Properties of Hydrogen Peroxide Bleached Sulphite

Treatment	G.E. brightness	Standard beater tests: Burst	Tensile	Tear
Unbleached sulphite	51–57	108	31	77
Mill bleached (2.25% Cl_2 + 4.25% Cl_2 as calcium hypochlorite)	81.3	94	30	82
2% H_2O_2 50% at 5% density	68.6	113	30	104
1.5% av. Cl_2 as HOCl pretreatment 2% H_2O_2 50% at 5% density	71.2	117	29	96
4.5% av. Cl_2 as HOCl pretreatment 2% H_2O_2 50% at 5% density	82.4	120	36	84
2% H_2O_2 50% cold steep	72.5	104	29	108
Unbleached sulphite	54.0	102	25	81
0.9% H_2O_2 50% cold steep	75.9	103	27	98
1.8% H_2O_2 50% cold steep	79.2	108	26	95

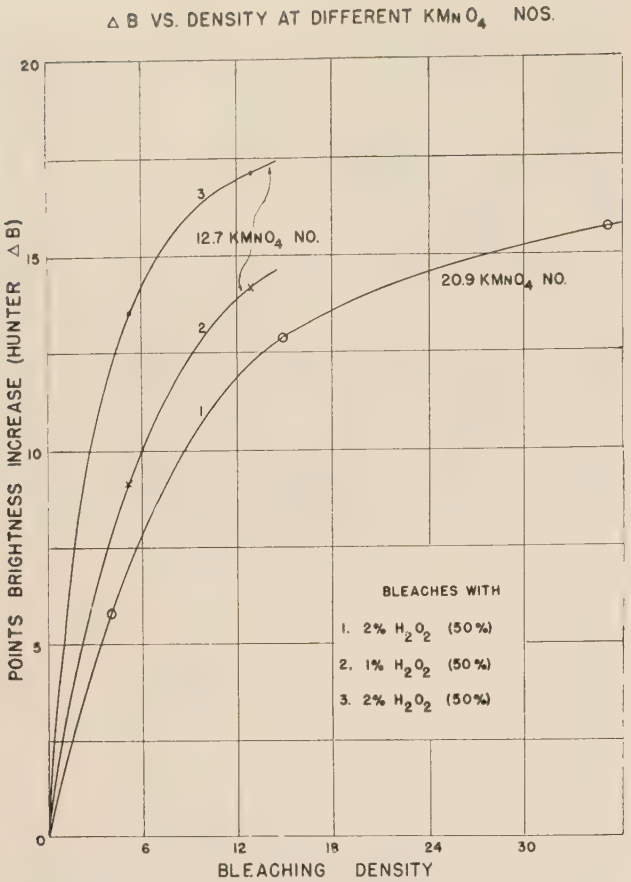
Δ B VS. DENSITY AT DIFFERENT KMnO4 NOS.
POINTS BRIGHTNESS INCREASE (HUNTER Δ B)
BLEACHING DENSITY
12.7 KMnO4 NO.
20.9 KMnO4 NO.
BLEACHES WITH
1. 2% H2O2 (50%)
2. 1% H2O2 (50%)
3. 2% H2O2 (50%)

Fig. 8. Effect of density in single-stage bleaching of unbleached sulphite

From the data of Table V and from the data of previous tables it will be seen that peroxide bleaching produces high brightness pulps of equal or superior physical strength. While the use of peroxide results in slightly higher chemical costs than does the use of conventional chlorine systems, it is believed that in relation to final brightnesses, high yields (about 99%), pulp properties, and over-all simplicity of operation, peroxide bleaching of sulphite has a definite place in the paper industry.

Kraft

Experience with kraft pulps has shown that hydrogen peroxide and such derivatives as peracetic acid are employed to best advantage following one or more purification stages. The use of peroxygen compounds on brown stock results in little brightening action, benefits being restricted mostly to shade changes. Generally, a chlorination stage followed by an alkaline extraction with or without a subsequent hypochlorite stage will suffice for purification requirements.

The economic use of hydrogen peroxide dictates its application in relatively small quantities, 0.25 to 1.0% hydrogen peroxide 50% based on moisture-free pulp. To realize the greatest chemical efficiencies, moderate to high density operation in a final-stage process is recommended. However, some very interesting results have been obtained by incorporating small amounts of hydrogen peroxide in the alkaline extraction stages (*34*). Similar results are shown in Table VI. The primary function of this step is not to achieve a definite brightness increment, but rather to prevent any color reversion due to the action of the hot alkali on the pulp. The amounts of hydrogen peroxide used in this manner should be relatively small, on the order to 0.25

Table VI. Effect of Hydrogen Peroxide in Kraft Alkaline Extraction Stages

Brown stock KMnO4 no.	*1st stage, % Cl2*	*2nd stage, % NaOH*	*G.E. brightness*	*3rd stage, % H2O2 50%*	*G.E. brightness*
12.0	2.3	1.5	38.8	0.8	67
12.0	2.3	1.5 + 0.4% H_2O_2 50%	47.5	0.8	71

Table VII. Viscosity and Brightness Results After Hydrogen Peroxide Stage in Kraft Bleaching

% H2O2 50%	*Temperature, °C.[a]*	*Bleaching density, %*	*Brightness Original*	*Brightness Final*	*Viscosity Original*	*Viscosity Final*
0.25	65	6	78.6	84.8	28	28
0.25	65	13	78.6	84.0	28	27
0.25	65	13	79.3	85.7	28	30
0.25	R.T.	32	74.9	84.3	..	..
0.5	49	13	78.6	85.0	28	28
0.5	65	13	78.6	86.8	28	28
0.5	65	13	79.3	85.5	28	27
0.5	R.T.	32	74.9	86.1	..	..
0.75	R.T.	32	74.9	86.9	27	26
1.0	65	13	79.8	86.7	28	25
1.0	R.T.	33	79.8	88.2	28	27
1.0	R.T.	27	70.3	86.2	13	13
1.0	R.T.	40	76.4	84.3	16	15
2.0	R.T.	33	79.8	89.5	28	28
0.75	R.T.	31	77.1	83.1	15	15
1.25	55	12	77.1	81.5	15	14
1.25% NaOCl	40	5	77.1	81.7	15	12
0.55	60	15	77.0	85.3	29	27
1% NaOCl	38	5	77.0	84.8	29	22
1.25% CH_3COOOH 40%	45	15	77.8	87.3	29	27
0.3% $NaClO_2$-NaOCl	50	5	77.8	88.5	29	23

[a] R.T. = cold steep bleach at room temperature.

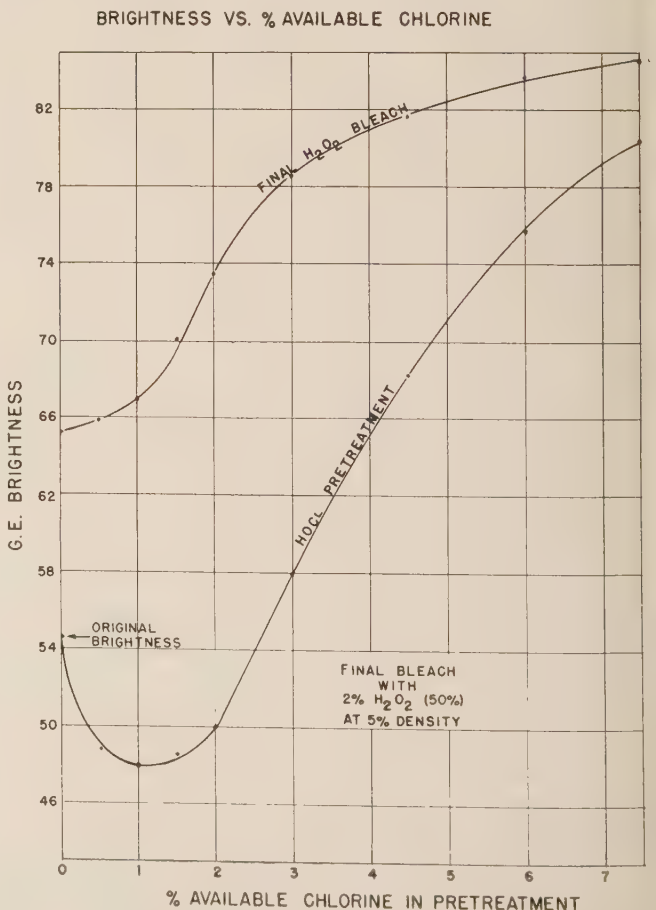
BRIGHTNESS VS. % AVAILABLE CHLORINE
G.E. BRIGHTNESS
% AVAILABLE CHLORINE IN PRETREATMENT
FINAL H2O2 BLEACH
HOCl PRETREATMENT
ORIGINAL BRIGHTNESS
FINAL BLEACH WITH 2% H2O2 (50%) AT 5% DENSITY

Fig. 9. Effect of HOCl pretreatment on sulphite brightness

Table VIII. Hypochlorite--Hypochlorite--Peroxide Bleaching of Kraft Pulps

Brown stock $KMnO_4$ no.	*1st stage, % $Ca(OCl)_2$*	*$KMnO_4$ no.*	*2nd stage, % $Ca(OCl)_2$*	*$KMnO_4$ no.*	*3rd stage, % H_2O_2 50%*	*G.E. brightness*
12.6	2.0	6.5	1.07	4.4	0.43	60.6
12.7	2.0	5.9	0.98	3.6	0.44	63.3
13.5	2.0	6.8	1.16	4.3	0.64	62.6
13.9	2.0	7.0	1.15	4.3	0.66	62.5
14.6	2.0	8.3	1.84	4.6	0.89	66.0
16.3	2.2	8.1	1.65	5.1	1.0	61.6

to 0.5% hydrogen peroxide 50% with 2.0 to 3.0% sodium silicate. Any greater use of peroxide can be applied to better advantage as a final stage bleach.

Improved physical properties of the pulp are one of the several advantages obtained by using hydrogen peroxide rather than the conventional chlorine methods in a final stage bleach. Typical pulp strengths, as measured by the standard cuprammonium viscosity test, before and after peroxide bleaching, are presented in Table VII. Several chlorine bleached pulps have been included for comparison.

The alkaline peroxide treatment gives increased fibrillation of the pulp, thus improving many of the pulp and finished paper properties such as formation, hydration, and tear. In addition, color permanence over the paper machine is excellent, thus permitting a lower bleach plant brightness to meet finished paper specifications. Reduced pulp shrinkage during bleaching and good color stability are also important factors resulting from peroxide usage.

The application of hydrogen peroxide in final stage kraft bleaching may be arbitrarily divided into three categories; as an antichlor for semibleached and bleached grades, to raise semibleached grades to a full bleached brightness, and to superbleach to the 85 to 90 brightness range. The method by which any of these processes is carried out is dependent on the equipment at hand and the finished paper requirements.

As previously mentioned, chlorination followed by alkaline extraction with or without a hypochlorite stage is usually sufficient purification prior to peroxide bleaching. Of particular interest is a method wherein the chlorination and alkaline extraction stages are replaced by several successive moderate density hypochlorite treatments prior to the peroxide final stage. This process is especially suitable for semibleached grades and has the distinct advantage of reducing pulp shrinkage. In mill operation this process has proved satisfactory, and Table VIII gives typical results obtained.

When hydrogen peroxide is used as an antichlor, either low, moderate, or high densities may be used. In the case of the first two, hydrogen peroxide requirements are 0.25 to 0.5% hydrogen peroxide 50% with 3 to 5% sodium silicate, and 0.1 to 0.3% sodium hydroxide.

Table IX. Hydrogen Peroxide as an Antichlor in Final Stage Kraft Bleaching

% H_2O_2 50%	*Temperature, °C.*	*Bleaching density, %*	*Brightness*		*Viscosity*	
			Original	*Final*	*Original*	*Final*
0.25	49	6	78.6	83.9	28	29
0.25	49	13	78.6	84.5	28	32
0.25	65	6	78.6	84.8	28	28
0.25	R.T.	32	74.9	84.3	..	..
0.50	49	6	79.3	84.6	..	..
0.50	49	13	78.6	85.8	28	27
0.50[a]	R.T.	40	76.4	84.5	16	15

[a] One side impregnation of pulp web.

Temperatures should be held to a minimum, preferably below 60°C., with retention times on the order of 1½ to 2 hours. If the antichlor is carried out at high density, such as in the cold steep bleaching, peroxide and silicate requirements are the same but caustic percentages should be somewhat lower (0.0 to 0.2%). Data of Table IX are representative of antichlor results that have been obtained in both mill and laboratory studies at various densities.

Hydrogen peroxide may also be used effectively to raise semibleached brightness to the 80 to 85 brightness level. The best efficiency is obtained through the use of the cold steep process. Bleaching conditions are the mildest possible and equipment investment is kept to a minimum. Chemical requirements are usually 0.25 to 1% hydrogen peroxide 50%, 3 to 6% silicate of soda, and 0.3 to 0.75% sodium hydroxide.

Bleaching of semibleached grades can also be carried out at moderate density. However, efficiencies are not as great as with high density methods and danger of degradation is greater because of the increased temperatures necessary. Peroxide and caustic requirements are generally higher; 0.5 to 1.25% and 1.0 to 1.25%, respectively. Typical of the results obtained in moderate and high density bleaching are those appearing in Table X.

In superbleaching of kraft pulps to the 85 to 90 brightness level, the mild conditions of the cold steep technique produce outstanding results with respect to pulp strengths and final brightness. To reach the same brightness level with a low or moderate density scheme usually requires temperature and alkalinity conditions severe enough to cause some fiber degradation. Chemical requirements for steeping are generally 0.5 to 1.0% hydrogen peroxide 50% with 3 to 6% sodium silicate, and 0.5 to 0.75% sodium hydroxide. Reference to Table X indicates typical cold steep results obtained in superbleaching.

In summary, it should be noted that with kraft pulps, highest efficiencies in relation to brightness and

Table X. Moderate and High Density Peroxide Bleaching of Kraft Pulps

% H_2O_2 50%	*Temperature °C.*	*Bleaching density, %*	*Brightness*		*Viscosity*	
			Original	*Final*	*Original*	*Final*
0.25	65	13	79.3	85.7	28	30
0.25	49	13	79.3	84.4	..	..
0.50	49	13	78.6	85.8	28	27
0.50	65	13	79.3	86.2	28	27
0.55	60	15	77.0	85.3	29	27
1.0	65	13	79.8	87.7	28	26
1.0	52	13	79.8	86.3	28	25
0.25[a]	R.T.	40	76.4	81.4	16	17
0.50	R.T.	32	74.9	86.1	27	..
0.75	R.T.	32	74.9	86.9	27	26
1.0	R.T.	33	79.8	88.6	28	27
1.0	R.T.	27	70.3	85.0	13	15
2.0	R.T.	27	70.3	87.2	13	12

[a] One side impregnation of pulp web.

Table XI. Brightness Response of Different Species to Steep Bleaching

Wood species	% H_2O_2 50%	Hunter brightness[a] Original	Final	ΔB
Poplar	1.25	57	71.0	14.0
Spruce—poplar	1.5	57.5	67.0	9.5
Western hemlock	1.6	53.0	62.5	9.5
Southern pine	1.5	56.0	65.0	9.0

[a] Calibrated to G.E. standard.

chemical costs are promoted through the use of high density operation. Here temperature and alkali conditions are the mildest possible, resulting in a minimum of cellulose degradation. Brightness stability of pulp in storage and as finished paper is excellent. Steeping operations require considerably lower equipment investment than do moderate and low density schemes. However, moderate density systems should not be overlooked since in many instances they can be adapted to give entirely satisfactory results.

Semichemical Pulps

Of the approximately 25 mills in the United States and Canada producing semichemical pulps, most production is for unbleached corrugating board, or wrapping grades. However, some book and coated grades can use about a 70 brightness semichemical pulp. If the pulping system is of the neutral sulphite type, this brightness may be obtained at about 98% yield with about 1.5 to 2.0% hydrogen peroxide 50%. Highest bleaching densities are most efficient. The savings in yield help to offset the cost of bleaching chemicals. Single-stage peroxide systems produce bleached pulp of about the same physical strengths as single-stage hypochlorite systems but at higher yields (*41*). In some cases, hypochlorite-peroxide systems (*42*) will produce intermediate yields and reduced chemical costs. Alkaline cooked semichemicals appear to have less brightness response to peroxide than those prepared by the neutral sulphite procedure.

Groundwood

There is no need to review the past process developments in the groundwood field. Most forecasted installation planning is for moderate or high density systems.

As mentioned earlier, the high density continuous tower system and the cold steep system are the newest high density developments. The latter system is operating commercially on a Kamyr web as well as on groundwood crumbs. The form of the pulp is incidental to the chemical process as densities in both cases approximate 33 to 35%. Using 1.3% hydrogen peroxide 50% and 4.5 to 5% silicate of soda, poplar or cottonwood pulp brightness is elevated from 58 to 70 to 72 in about 1 to 3 days at existing temperatures. A typical brightening rate may be seen from Fig. 2. Other groundwood pulp types respond as shown in Table XI. Because in groundwood steeping the pulp is of neutral pH at the point of maximum brightness, brightness stability is good for reasonable storage periods. After bleaching, the pulp needs no neutralization and may be added directly to the paper furnishing equipment. Bleached and unbleached pulp qualities are substantially the same.

Table XII. Effect of HOCl Pretreatment on Western Hemlock Groundwood

	G.E. brightness	
	No pretreatment	HOCl pretreatment
Unbleached	56.0	56.0
HOCl pretreated	...	54.5
Bleached 2% H_2O_2 50%	60.0	65.5

Reduction of the steeping time required for efficient brightening is at present under commercial study. It is indicated that times may be reduced to hours instead of days, where shorter times are desirable.

Another interesting groundwood development is the application of a hypochlorous acid pretreatment (0.5% available chlorine at pH 7.0 to 8.0 and low density) prior to hydrogen peroxide bleaching (*1*, *9*). Benefits of the pretreatment depend on the wood type and quality, and are determined empirically. On western hemlock groundwood, or mixtures containing western hemlock, its value has been outstanding (Table XII).

Peroxide bleaching of chemigroundwood pulp (*8*) has so far been carried out on a laboratory and pilot plant basis. Neutral sulphite chemigroundwoods generally require somewhat higher alkalinities for peroxide bleaching than do regular groundwoods. Typical results may be seen in the Table XIII.

Table XIII. Response of Poplar Neutral Sulphite Chemigroundwood

	Hunter brightness[a]
Unbleached	55.0
Bleached 5% density using 1.7% H_2O_2 50%	67.0
Bleached 5% density using 2.5% H_2O_2 50%	70.0

[a] Calibrated to G.E. standard.

Moderate and high density operations will increase the above brightness levels at equivalent per cent hydrogen peroxide, or produce equal brightnesses at reduced peroxide levels. Increased strengths compared to normal groundwoods make this pulp type one of high utility, when it has been peroxide bleached to the 65 to 70 brightness level.

Other Pulp Types

Studies on the pulping of agricultural residues have been undertaken by the Northern Regional Research Laboratories, and bleaching studies have been carried out in the BECCO Laboratories. Kraft and soda, as well as neutral sulphite pulping procedures were applied to wheat straws. Peroxide bleaching produced greatest response when the neutral sulphite and kraft methods were used. Hypochlorous acid pretreatments (3% available chlorine) prior to peroxide bleaches increased the over-all bleaching efficiency without major

Table XIV. Response of Wheat Straw Pulps to H_2O_2 Bleaching

Straw pulp type	HOCl pretreatment % av. Cl_2	% H_2O_2 50%	Hunter brightness[a] Unbleached	Pretreated only	H_2O_2 bleached
Neutral sulphite	3.0	0.55	34.2	46.1	61.2[b]
Kraft	3.0	1.1	24.8	38.4	63.6[b]
NaOH	3.0	1.1	21.5	21.2	24.4

[a] Calibrated to G.E. standard.
[b] On bleaching, physical tests increased as follows: burst, +0 to 8%; tear, +17 to 40%; tensile, +2 to 5%; and fold endurance, +5 to 10%.

Table XV. Effect of HOCl Pretreatment on Bagasse Pulp Brightness

Pulp type	HOCl pretreatment % av. Cl_2	% H_2O_2 50%	Hunter brightness[a] Unbleached	Pretreated only	H_2O_2 bleached
Neutral sulphite	1.0	2.0	48.0	58.7	71.2
Neutral sulphite	...	2.0	48.0	..	59.3
Kraft	3.0	2.0	33.8	42.5	65.1
Kraft	...	2.0	33.8	..	48.0

[a] Calibrated to G.E. standard.

yield loss (1.5%). Peroxide's value appears to lie in its ability to bleach at high yield. In addition, based on similar studies, pulps of improved brightness permanence over single-stage hypochlorite systems should be expected. Typical bleaching results are shown in Table XIV.

Bagasse pulps, prepared by neutral sulphite as well as kraft methods, were bleached with hydrogen peroxide at varying densities. The value of a hypochlorous acid pretreatment is unquestionable, as is the use of moderate or high densities. Table XV presents some typical results.

Flax pulps have been bleached with hydrogen peroxide in the last stage of a multistage chlorine system. Chlorinated and caustic extracted flax may be bleached as seen in Table XVI.

Studies are continuing on the above pulp types whereby yield and quality features of hydrogen peroxide bleaching may be evaluated.

Deinking of waste papers has been thoroughly reviewed (*43*, *44*), and the economical use of peroxides established for wastes containing groundwood. In addition, for the purpose of brightening and controlling shade variations of deinked stock batches, some mills use peroxides in high density ledger reclaiming operations.

It is anticipated that research and development studies presently under way on rag cooking and bleaching operations may reveal procedures for the economical use of peroxides therewith. Most rags have originally been bleached with hydrogen peroxide in the textile piece goods form, and rag recovery studies may show interesting systems for maintaining cellulose quality.

APPLICATION TRENDS

Investigations to date have indicated some new and efficient systems for bleaching chemical and mechanical pulps with hydrogen peroxide. Continued mill evaluation will further establish the economics of these methods. Increased development research in the field of peroxide bleaching it is hoped will result in greater uniformity, simplicity, and efficiency of operation.

Future studies will be directed toward the development of methods which will result in high pulp yields and improved physical qualities at lower cost.

Table XVI. H_2O_2 Bleach Response of Chlorinated and Caustic Extracted Flax Pulp

Method	% H_2O_2 50%	Hunter brightness[a] Original	Final
Low density, 50°C.	1.7	48.5	78.0
Mod. density, 50°C.	1.0	48.5	78.5
High density, 50°C.	1.0	48.5	79.0
High density steep	1.25	53.4	82.3

[a] Calibrated to G.E. standard.

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Corrosion of Mild Steel and Mild Steel Welds in Sulphate Digesters

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This paper consists of a report on a large-scale test program initiated to obtain more exact relative corrosion resistance of mild steels and mild steel welds in the sulphate process. Specifically the following points were to be studied: (1) relative corrosion resistance of modern semikilled and fully killed steels; (2) corrosion resistance as related to exact chemical analyses; (3) the effect of surface finish; (4) comparative tests on several mild steel welds—manual and submerged arc; (5) corrosion resistance of several low alloy high tensile steels; (6) data on the galvanic effect obtained by coupling mild steel to several stainless steels; (7) the effect of various heat treatments. Exposure was for slightly over 1 year in a tumbling digester on the West Coast. Specimens were large, measuring up to 36 inches long by 15 inches wide by 3/4 inch thick and so installed as to be subjected to the same conditions throughout. Also specimens were installed so as to be subjected to the same wiping action the digester wall undergoes. Results can be summarized as follows: (1) Corrosion rate of plate stock varied from 0.028 inch per year for semikilled A285 to 0.138 inch per year for the highest silicon, low alloy steel. Corrosion rate was almost directly proportional to silicon content and the addition of up to nearly 1% of chromium, nickel, or manganese with smaller additions of copper and molybdenum had no effect. The same general condition prevailed with the weld deposits although here the relationship was not entirely linear. (2) Surface preparation has some effect with best resistance shown by plate covered with the hot-rolled mill scale and poorest shown by a sandblasted surface. (3) Heat treatment above the critical range for the steel markedly lowers corrosion resistance. (4) The galvanic effect is not dangerously severe with Type 347 or Inconel. Type 430 straight chromium steel causes some accelerated corrosion of mild steel when electrically coupled in unfavorable area relationships.

THE test program reported in this paper was installed in a tumbling digester on the West Coast in July, 1949. The tumbling process does not represent the major use for alkaline pulping in the kraft industry, but was selected for the test exposure because of the severe corrosion conditions known to be present. The tumbling process employs direct cooking, and the test program specimens were located near the trunnions away from the point of steaming which was in the discharge cone. From the general observations of corrosion in the particular digester used during the test exposure it can be said that the specimens were exposed to a uniform corrosion environment being alternately exposed to liquor and vapor conditions of the cook.

From our experience and observations of corrosion in the kraft industry, we believe that the test results and conclusions of this program would apply to vertical stationary digesters for alkaline pulping. The corrosive conditions of the cook are more severe than is usual for stationary digesters because the liquor used is 100% white liquor of high causticity and sulphidity.

After this test program was installed we became aware of the Swedish investigation reported by C. G. Von Essen (*Tappi* 33: July, 1950) which concluded that the presence of silicon in steel decreased its resistance to corrosion. This same investigation reported better corrosion resistance with nickel-containing steels.

The results of our test program bear out some of the Swedish findings insofar as the silicon content is concerned but do not compare favorably with the effect of low alloy additions found in Sweden.

Of importance to the industry is our finding that high oxygen content in the steel surface is very beneficial to high corrosion resistance. In the steels examined from "old" digesters, we conclude that the product was probably of Bessemer practice. One steel tumbling digester in service 22 years was originally German Bessemer steel. In our opinion the presence of high oxygen content either in solution or as oxides in the steel may have beneficial effects insofar as the formation of a continuous protective calcite scale. From our tests of weld metal it is also apparent that high oxygen weld metal (usually detrimental to best x-ray quality) rates as highly corrosion resistant.

The open hearth rimming steels made today offer the low silicon content found to be beneficial, but because of their usual purity, especially in the rim portion at the surface, do not contain sufficient oxygen to compare with steels of old vintage.

HISTORY

Corrosion of carbon steel equipment, especially digesters, in the sulphate process is a matter of growing concern to the paper industry. Stainless steels are now widely used and are generally very satisfactory although more expensive and, at the present time, hard to obtain. In many cases, however, corrosion of carbon steel equipment is severe enough to cause short life yet scarcely rapid enough to dictate the expense of a stainless steel installation. During the last 10 years, especially, we have heard and read a good deal about accelerated corrosion of mild steel plates and preferential corrosion of welds in such mild steel plate operating in the sulphate process (*1*, *2*). In an effort to obtain some comparative field tests which might point the way to more corrosion-resistant mild steel plate and welds, the A. O. Smith Corp. initiated and carried out a rather extensive test program. Exposure was for slightly over a year in a very corrosive installation on the West Coast. The program was set up to yield in-

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Table I. Description

Plate no.	Plate type	Weld description	Dimensions, in. Length	Width	Thickness
1	ASTM A-285, Grade C, four surface conditions[a]	AWS 6020, 1 seam Low nickel submerged arc, 1 seam Welds ground flush with plate	36	15	0.76
2	ASTM A-212, Grade B, four surface conditions	AWS 6013, simulated field seam AWS 7020, 1 seam Welds ground flush with plate	36	15	0.75
3	ASTM A-201, Grade A, sandblasted	AWS 6010 and AWS 6012, 1 seam Oxweld 36 and 40 submerged arc, 1 seam Welds not ground	36	15	0.77
4A	ASTM A-212,	AWS 7020, 1 seam	12	15	0.75
4B	Grade B,	Low nickel submerged arc, 1 seam	12	15	0.75
4C	sandblasted	Welds ground flush with plate	12	15	0.75
5A	ASTM A-285 Grade C, sandblasted	AWS 6020, 1 seam Low nickel submerged arc, 1 seam Welds not ground	12	15	0.77
5E	Low alloy	AWS 10020, 1 seam	5	15	0.75
5F	high tensile	Low nickel submerged arc, 1 seam			
5G	steels,	Welds not ground			
5H	all sandblasted				

[a] Surface conditions were as follows: 1, hot-rolled finish, no treatment; 2, sandblasted; 3, ground; 4, peened and ground.

formation on the following aspects of corrosion of mild steel plate:

A—Relative corrosion resistance of modern semikilled and fully killed steels.

B—Corrosion resistance as related to chemical analysis. Obviously this chemical analysis should be made on the metal surface exposed and not on the cross section. In the semikilled steel some variation exists between the outer skin and the center of the plate.

C—The effect of surface finish.

D—Relative corrosion resistance of several mild steel weld deposits, both manual and submerged arc. It was hoped to find a weld metal deposit resistant to the washing out often encountered.

E—Corrosion resistance of low alloy high tensile steels. These steels have been recommended for sulphate service and their suitability needed investigation.

F—Data on the galvanic effect obtained by coupling various stainless types to carbon steel. The open circuit potential obtained between carbon steel and stainless is fairly high; however

Fig. 1

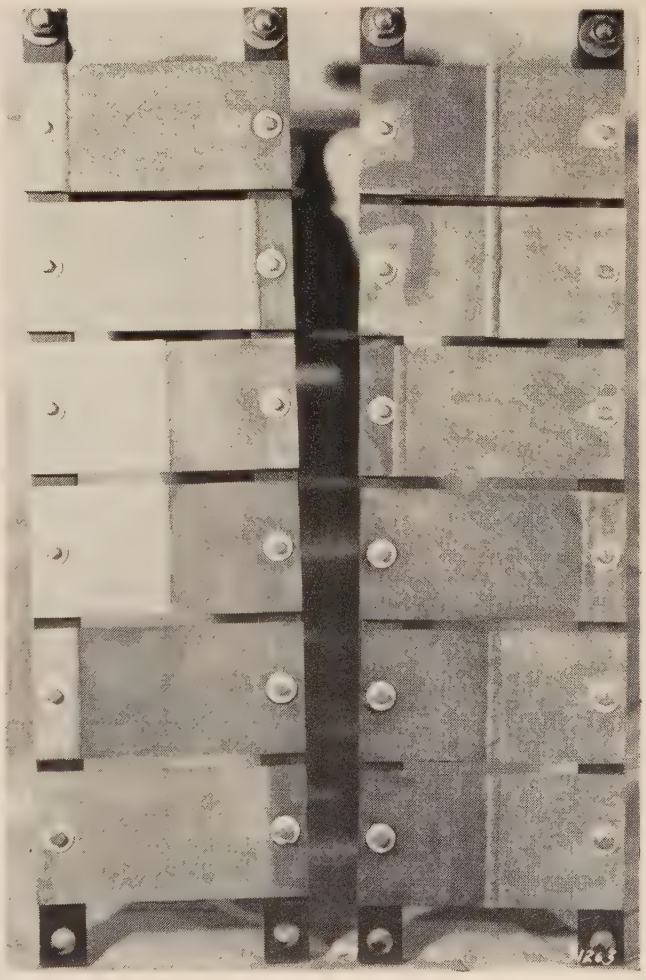

Fig. 2

Table II. Chemical Analysis

Plate no.	Plate type	C	Mn	P	S	Si	Cr	Ni	Mo	Cu	V
1	A-285 stock	0.18	0.45	0.010	0.016	0.01	...	...	...	*0.03*	...
	AWS 6020 deposit	0.08	*0.31*	...	...	0.13	...	...	...	*0.03*	...
	Low nickel deposit	0.11	*0.43*	...	...	0.25	...	0.46	...	*0.03*	...
2	A-212 stock	0.23	0.67	0.011	0.031	0.21	...	...	...	*0.03*	...
	AWS 6013 deposit	0.11	*0.36*	...	...	0.45	...	...	...	*0.04*	...
	AWS 7020 deposit	0.10	*0.32*	...	...	0.13	...	...	*0.42*	*0.04*	*0.04*
3	A-201 stock	0.13	0.55	0.017	0.037	0.16	...	...	...	*0.03*	...
	AWS 6012 deposit	0.06	*0.21*	...	...	0.09	...	...	...	0.04	...
	AWS 6010 deposit	0.10	*0.34*	...	...	0.15	...	...	...	0.06	...
	Oxweld 36 deposit	0.11	*1.25*	...	...	0.37	...	...	...	0.12	...
	Oxweld 40 deposit	0.09	*0.70*	...	...	0.35	...	...	*0.08*	0.15	...
4A, B, C	A-212 stock	0.23	0.67	0.011	0.031	0.21	...	...	...	*0.03*	...
	AWS 7020 deposit	0.10	*0.32*	...	...	0.13	...	...	*0.42*	*0.04*	*0.04*
	Low nickel deposit	...	*0.70*	...	...	*0.35*	...	*0.47*	*0.05*	*0.03*	...
5A	A-285 stock	0.14	0.48	0.010	0.016	0.01	...	...	...	...	...
	AWS 6020 deposit	0.08	*0.43*	...	...	0.15	...	...	*0.02*	*0.02*	...
	Low nickel deposit	0.09	*0.59*	...	...	0.23	...	*0.45*	*0.10*	*0.02*	...
5E	Stock	0.10	*0.86*	0.110	0.023	0.57	*0.45*	*0.61*	*0.11*	*0.48*	...
	AWS 10020 deposit	0.11	*0.59*	...	...	0.23	*0.32*	*1.80*	*0.84*	*0.30*	*0.12*
	Low nickel deposit	0.05	*0.77*	...	...	0.54	*0.36*	*1.02*	*0.14*	*0.29*	...
5F	Stock	0.19	*0.23*	0.017	0.028	0.20	...	*0.79*	*0.02*	*0.42*	...
	AWS 10020 deposit	0.09	*0.60*	...	...	0.28	*0.30*	*1.86*	*0.85*	*0.26*	*0.12*
	Low nickel deposit	0.14	*0.73*	...	...	0.37	...	*0.84*	*0.11*	*0.18*	...
5G, H	Stock	0.14	*0.76*	0.022	0.025	0.84	*0.58*	*0.17*	*0.15*	*0.12*	...
	AWS 10020 deposit	0.10	*0.59*	...	...	0.27	*0.46*	*1.48*	*0.63*	*0.03*	*0.11*
	Low nickel deposit	0.10	*0.77*	...	...	0.69	*0.49*	*0.51*	*0.16*	*0.07*	...

Chemical analyses of plates 1, 2, 3, 4, and 5A were made on exposed surface. Variation was not great except on plate 5A.
Plate 5: Average analysis: C, 0.24; Si, 0.03; P, 0.010; S, 0.035. Rim analysis: C, 0.14; Si, 0.01; P, 0.010; S, 0.016.
Italic figures indicate spectrographic analysis.

under closed circuit conditions polarization and film formation often nullify the galvanic effect.

G—The effect of various heat treatments.

PREPARATION OF TESTS AND RESULTS

Considerable confusion on corrosion data exists regarding mild steel in the sulphate process of digestion. It was felt that much of this was due to specimen size and exposure. With this in mind fairly large welded plates were prepared for this program and so installed as to be subjected to the same scouring or wiping action as the digester wall. Corrosion rates were determined by direct measurement on the exposed face.

Table I lists plate types, welds, and dimensions. Table II gives the chemical composition of plates and welds.

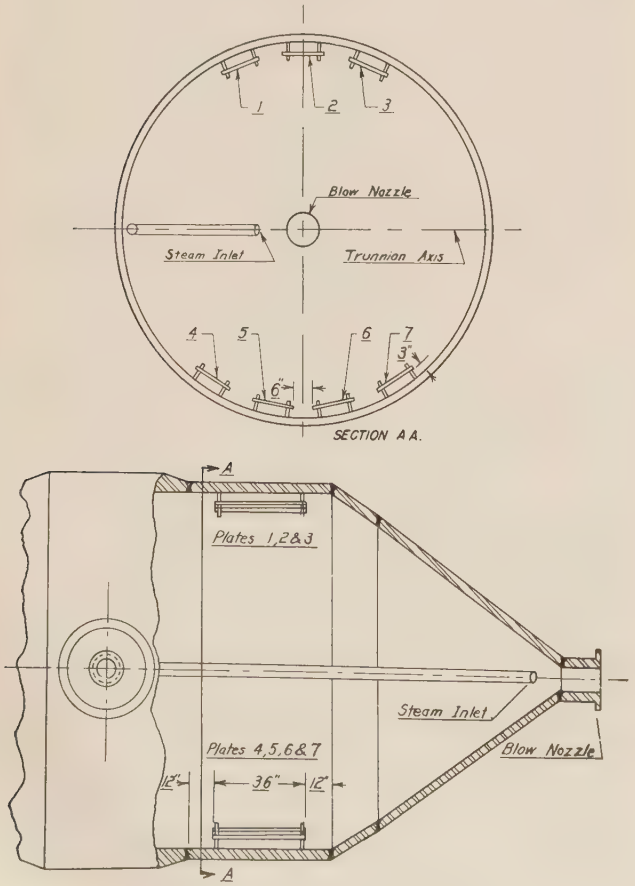

Fig. 3. Installation sketch

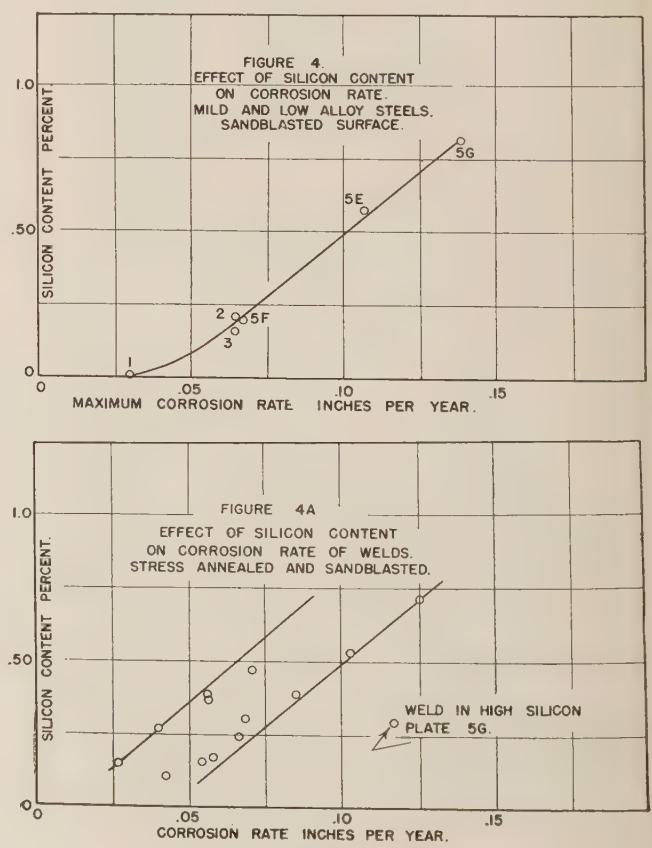

Fig. 4

Plate 5F
Stock: Si, 0.20%; 0.067 i.p.y. Weld: Si, 0.28%; 0.069 i.p.y.

Plate 5E
Stock: Si, 0.57%; 0.110 i.p.y. Weld: Si, 0.23%0 0.068 i.p.y.

Plate 5G
Stock: Si, 0.84%; 0.138 i.p.y. Weld: Si, 0.27%; 0.117 i.p.y.

Fig. 5

effect of silicon content on corrosion resistance. This effect is further shown in Fig. 4 where the corrosion rate of the plate stock is plotted as a function of silicon content. Surprisingly enough the addition of less than 1% of chromium, nickel, or copper has no effect on corrosion resistance when silicon is present. In the case of the welds the effect of increased silicon is to lower corrosion resistance also. Here, however, the relationship is not as nearly a straight-line function. This is easy enough to understand, for the normal chemical analysis gives the total silicon content, whether present as silica (SiO_2), siliceous slag, or silicide. As a result there is considerable scatter in the corrosion rates of the welds as plotted against their silicon content which is shown in Fig. 4A. The highest silicon content of weld metal shows the greatest corrosion while the lowest silicon has

Table III. Plate Stock Corrosion Rate, Inches per Year

Plate no.	*Plate type*	*Surface condition*	*Heat treatment*	*Corrosion rate, in./yr.* Average	Maximum
1	A-285, Grade C	Hot rolled	Stress anneal 1150–1200°F.	0.011	0.015
		Sandblasted	Stress anneal 1150–1200°F.	0.021	0.028
		Sandblasted and ground	Stress anneal 1150–1200°F.	0.020	0.024
		Sandblasted, peened, and ground	Stress anneal 1150–1200°F.	0.015	0.019
2	A-212, Grade B	Hot rolled	Stress anneal 1150–1200°F.	0.045	0.053
		Sandblasted	Stress anneal 1150–1200°F.	0.052	0.065
		Sandblasted and ground	Stress anneal 1150–1200°F.	0.046	0.051
		Sandblasted, peened, and ground	Stress anneal 1150–1200°F.	0.048	0.056
3	A-201, Grade A	Sandblasted	Stress anneal 1150–1200°F.	0.046	0.065
4A	A-212, Grade B	Sandblasted	1300°F. 2 hr. furnace cool	0.098	0.127
4B	A-212, Grade B	Sandblasted	1450°F. 1 hr. furnace cool	0.087	0.107
4C	A-212, Grade B	Sandblasted	1600°F. 1 hr. furnace cool	0.094	0.122
5A	A-285, Grade C	Sandblasted	1600°F. 1 hr. furnace cool	0.082	0.105
5E	Low alloy high tensile	Sandblasted	Stress anneal 1150–1200°F.	0.106	0.110
5F		Sandblasted	Stress anneal 1150–1200°F.	0.065	0.067
5G		Sandblasted	Stress anneal 1150–1200°F.	0.120	0.138
5H		Sandblasted	Normalize 1650°F.	0.130	0.135

Figure 1 shows a typical welded plate before installation. Small stainless steel pins were shrunk in each plate near the corner. The plates were then supported by these pins on a layout table and a series of surface measurements (144 on each of the 36-inch plates) made before and after exposure using the stainless pins as benchmarks. Thickness measurements of the pins before and after exposure showed no measurable corrosion.

Figure 2 shows the 12 specimens included to study galvanic effects. Various ratios of alloy to carbon steel were prepared. These specimens were very carefully insulated by Teflon and the insulation was intact at the time they were removed. Figure 3 is a sketch which shows the location of the specimens in the digester. Exposure was for a period of 432 days in a 4-ton tumbling digester on the West Coast operating on about 55% causticity and 25% sulphidity with 100% white liquor. Table III gives results obtained for the plate stock, and Table IV gives corrosion rates observed on the various weld deposits. Table V gives results of the exposure on the galvanically coupled specimens.

EFFECT OF SILICON

The outstanding result of the test is the pronounced

Fig. 6. Globular silicate inclusions which appear bright under polarized light

At higher magnification individual inclusions show a dark optical cross. Unetched. 500×.

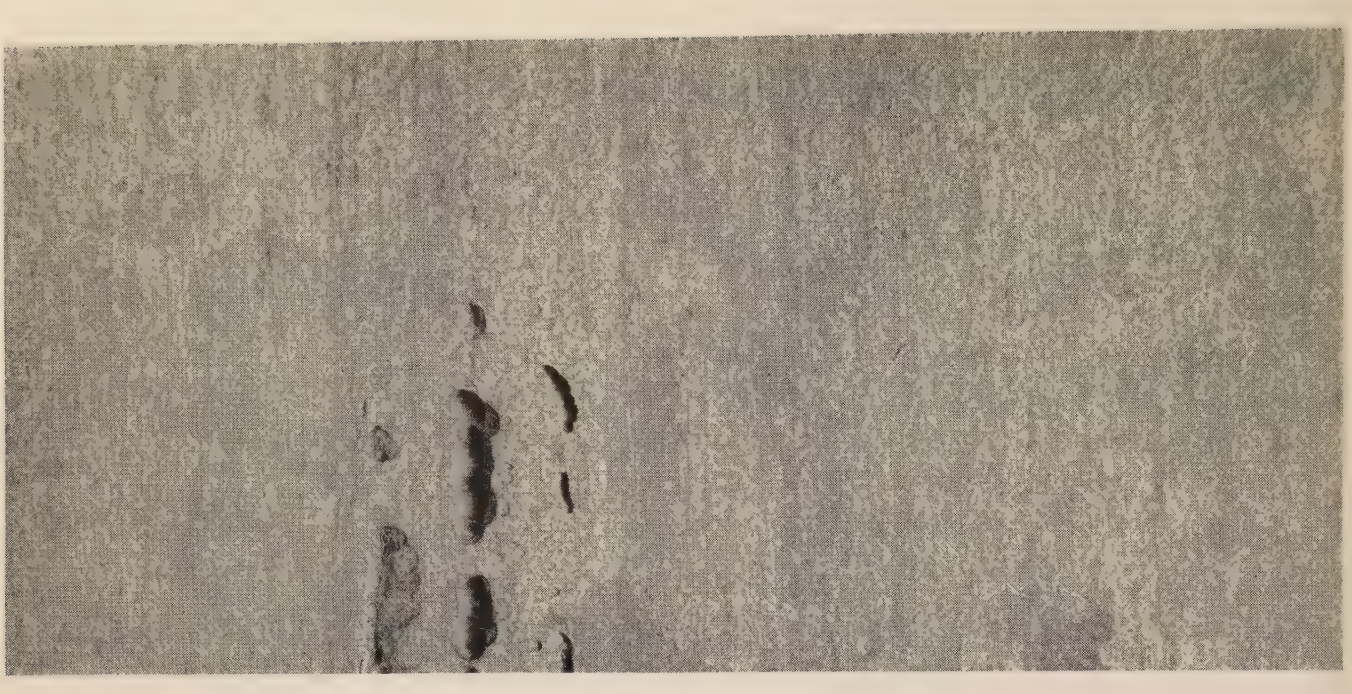

Fig. 7

the highest corrosion resistance. The one point outside the band which showed a higher corrosion rate than normal was made in the highest silicon plate where very severe plate corrosion left the weld in considerable relief. Throughout the test it was apparent that a plate which was actively corroded would cause accelerated corrosion of a relatively resistant weld deposit. This is further shown in Fig. 5 where the relative corrosion of plate and weld in three silicon bearing steels is shown. These welds were not ground flush before exposure. The same electrode was used in welding each plate. Dilution of the weld by the stock results in higher silicon welds in the high silicon plates. This in turn causes a higher corrosion rate. Silicon content of the deposit in plate 5F is actually higher than plate 5E because of the deeper welding groove and resultant increase in dilution of the deposit by the stock.

The AWS 6013 deposit in plate No. 2, which shows severe general corrosion and pitting is interesting because it also shows a high silicon content. The coating of this electrode is high in potassium silicate, and the slag-metal relationship is such as to leave numerous globular silicates in the deposit. This is shown in Fig. 6 where a micrograph of the AWS 6013 deposit was taken under polarized light. Silicate inclusions are active (appear bright) under polarized light and the dark optical cross seen in the globular inclusions is a positive identification (*3*). These silicate inclusions are detrimental in that they result in general corrosion and pitting as shown in Fig. 7.

Effect of Surface Condition

It is apparent that surface preparation can affect the corrosion rate of mild steel in sulphate digester service.

Fig. 8

Table IV. Corrosion Rate of Welds

Plate no.	Plate type	Weld type	Heat treatment	Silicon content, %	Corrosion rate, in./yr. Average	Corrosion rate, in./yr. Maximum	Remarks
1	A-285	AWS 6020	Stress anneal 1150–1200°F.	0.13	0.018	0.023	No pitting
		Low nickel[a]	Stress anneal 1150–1200°F.	0.25	0.031	0.045	No pitting
2	A-212	AWS 6013	As-welded	0.45	0.058	0.085	Pitted 0.045 in.
		AWS 7020	Stress anneal 1150–1200°F.	0.13	0.042	0.048	No pitting
3	A-201	AWS 6012	Stress anneal 1150–1200°F.	0.09	0.038	0.043	No pitting
		AWS 6010	Stress anneal 1150–1200°F.	0.15	0.048	0.059	No pitting
		Oxweld 36[a]	Stress anneal 1150–1200°F.	0.37	0.049	0.057	No pitting
		Oxweld 40[a]	Stress anneal 1150–1200°F.	0.35	0.057	0.058	No pitting
4A	A-212	AWS 7020	1300°F. 2 hr. furnace cool	0.13	0.090	0.093	No pitting
	A-212	Low nickel[a]	1300°F. 2 hr. furnace cool	0.35	0.093	0.108	Pitted 0.078 in.
4B	A-212	AWS 7020	1450°F. 1 hr. furnace cool	0.13	0.078	0.081	No pitting
	A-212	Low nickel[a]	1460°F. 1 hr. furnace cool	0.35	0.076	0.081	Pitted 0.078 in.
4C	A-212	AWS 7020	1600°F. 1 hr. furnace cool	0.13	0.084	0.089	No pitting
	A-212	Low nickel[a]	1600°F. 1 hr. furnace cool	0.35	0.077	0.078	Pitted 0.185 in.
5A	A-285	AWS 6020	1600°F. 1 hr. furnace cool	0.15	0.076	0.092	No pitting
	A-285	Low nickel[a]	1600°F. 1 hr. furnace cool	0.23	0.976	0.085	No pitting
5E	Low alloy high tensile steels	AWS 10020	Stress anneal 1150–1200°F.	0.23	0.065	0.068	No pitting
		Low nickel[a]	Stress anneal 1150–1200°F.	0.54	0.098	0.104	No pitting
5F		AWS 10020	Stress anneal 1150–1200°F.	0.28	0.068	0.069	No pitting
		Low nickel[a]	Stress anneal 1150–1200°F.	0.37	0.078	0.086	No pitting
5G		AWS 10020	Stress anneal 1150–1200°F.	0.27	0.114	0.117	No pitting
		Low nickel[a]	Stress anneal 1150–1200°F.	0.69	0.119	0.126	No pitting
5H		AWS 10020	Normalize 1650°F., air cool	0.27	0.103	0.115	No pitting
		Low nickel[a]	Normalize 1650°F., air cool	0.69	0.148	0.154	No pitting

[a] Submerged arc weld.

The original plate surface with a hot-rolled mill scale intact shows the best resistance and the sandblasted surface shows the poorest resistance. Figure 8 shows the typical appearance where areas covered by mill scale are not attacked while areas not protected corrode rapidly. This photograph was taken of the back side of plate 2 and is typical of the attack on A-212 stock in some cases.

Obviously, since an impervious mill scale coating is impossible, it cannot be expected that such a coating could be depended upon to protect a digester. In fact local breaks in the scale could result in accelerated attack as shown in Fig. 8. In low silicon high oxygen steel these breaks appear to repair themselves while the silicon killed steel shown in Fig. 8 continues to corrode in a manner often called "bright spot" corrosion.

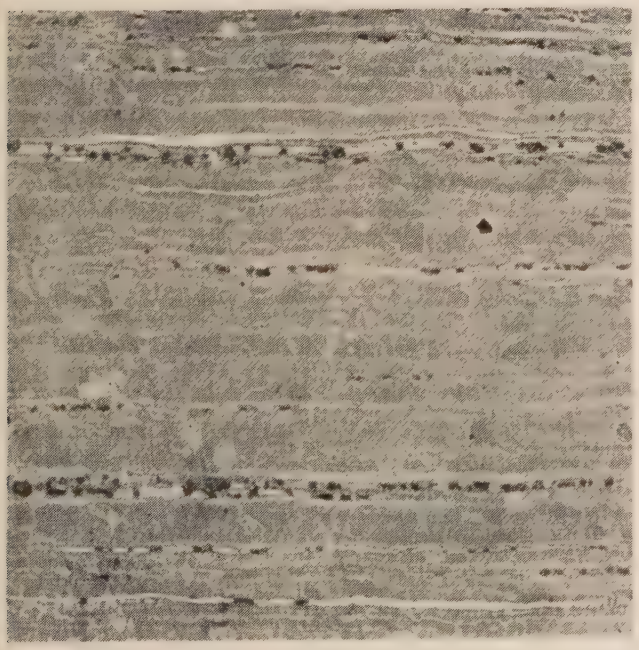

Fig. 9. Halls oxygen etch

Typical banded appearance of steel high in oxygen. Light areas are regions of high oxygen concentration. Usually these areas contain oxide inclusions. Taken from steel C, section 3, Table VI. 100×.

Effect of Galvanic Coupling on Corrosion of Carbon Steel

Galvanic corrosion of carbon steel when welded to Inconel or Type 347 stainless is not dangerously severe. The carbon steel welded to Type 430 (a 14 to 18% chromium stainless) shows accelerated corrosion of the carbon steel when the area of alloy steel is as large or larger than the area of the carbon steel.

This should not be taken as a blanket endorsement of coupling dissimilar metals in sulphate service. It is entirely possible that accelerated corrosion of carbon steel could result, for example, when a silicon killed steel which has very poor protective film forming properties is used.

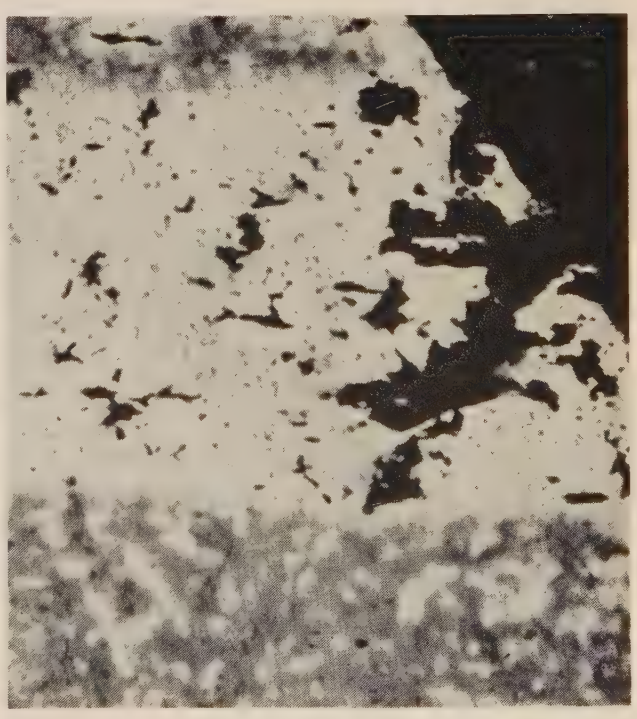

Fig. 10. Halls oxygen etch

Section through tensile specimen of steel C, section 1. The poor ductility of the high oxygen band is evident from the fissures which appeared when testing. Over-all ductility was low. 100×. Ultimate strength, 61,400 p.s.i.; yield strength, 34,800 p.s.i.; elongation % in 2 in., 24.0%; reduction of area, 26.5%.

Table V. Galvanic Corrosion, Plates 6 and 7

Alloy type	*Area relationship (alloy steel to carbon steel)*	*Heat treatment*	*Corrosion rate of carbon steel, in./yr.*
430	1 Alloy to 1 carbon steel	As-welded	0.050
430	1 Alloy to 1 carbon steel	1550°F. 1 hr. furnace cool	0.053
430	8 Alloy to 1 carbon steel	As-welded	0.077
430	1 Alloy to 6 carbon steel	As-welded	0.035
Inconel	1 Alloy to 1 carbon steel	As-welded	0.055
Inconel	1 Alloy to 1 carbon steel	1550°F. 1 hr. furnace cool	0.044
Inconel	8 Alloy to 1 carbon steel	As-welded	0.029
Inconel	1 Alloy to 6 carbon steel	As-welded	0.032
347	1 Alloy to 1 carbon steel	As-welded	0.031
347	1 Alloy to 1 carbon steel	1550°F. 1 hr. furnace cool	0.026
347	8 Alloy to 1 carbon steel	As-welded	0.037
347	1 Alloy to 6 carbon steel	As-welded	0.033

[a] Carbon steel analysis: C, 0.20; Mn, 1.51; Si, 0.10; P, 0.011; S, 0.020.
Corrosion rate determined by weight loss. Results are not as accurate as those given in Tables III and IV and represent average penetration.
Weld metal used: Type 430 to carbon steel, Type 430 electrode; Type 347 to carbon steel, Type 310 + Cb electrode; Inconel to carbon steel, 80 chrome–20 nickel electrode.

Effect of Heat Treatment

Some heat treatments at or above the critical temperatures have a very detrimental effect on the corrosion rate of steel. Hot-rolled and stress-annealed (1200°F. max.) plate with carbide in the form of a fine pearlite shows the greatest corrosion resistance.

Effect of Oxygen in Steel

In Fig. 4 the variation of the corrosion rate with silicon content is shown to be a straight-line function for killed steels. In semikilled or rimmed steels the oxygen content can impart greatly increased corrosion resistance. We have examined several steel sections cut from kraft digesters which reputedly gave exceptionally long life (20 years and longer) and these sections all showed low silicon and appreciable oxygen banding.

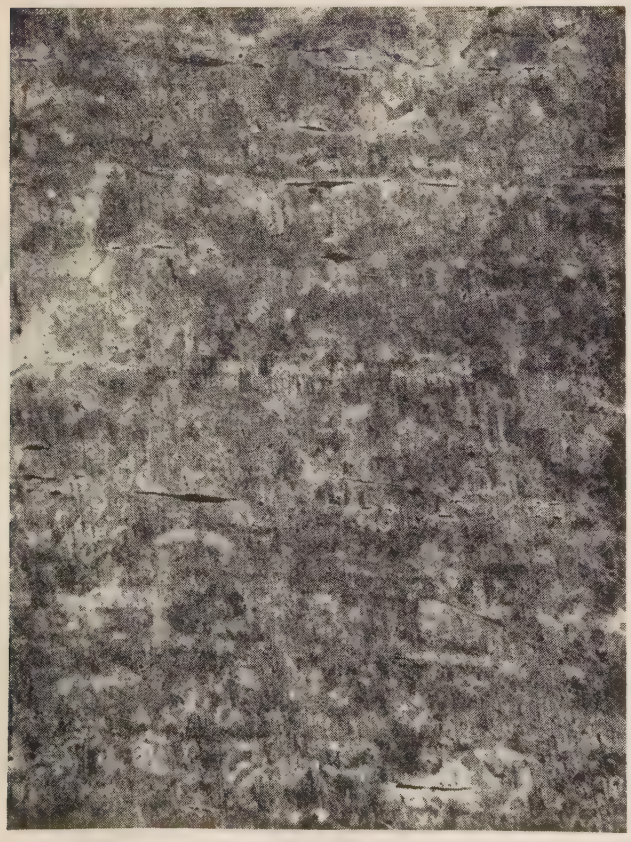

Fig. 11. Halls oxygen etch

Appearance of killed steel (D-1, Table VI) after etching as in Figs. 9 and 10. No high oxygen bands can be seen. Steel D, good corrosion resistance, was identical in appearance to steel C shown in Fig. 9. 100×.

Table VI gives description and chemical analyses of these steels.

Table VI. Old Digester Steels

Steel A—Tumbling digester, West Coast mill. Steel B—Vertical stationary digester, Southern mill. Steel C—Very old riveted digester, North Central mill. Steel D—Old stationary digester, Southern mill, 20 years. Steel D-1—New stationary digester, showing rapid corrosion, 3 years

Steel	*C*	*Mn*	*Si*	*P*	*S*
A	0.18	0.42	0.03	0.010	0.023
B	0.17	0.49	0.09	0.015	0.022
C, sect. 1[a]	0.24	0.39	0.04	0.054	0.071
sect. 2[a]	0.24	0.32	0.01	0.012	0.049
sect. 3[b]	0.13	0.43	0.06	0.012	0.040
D	0.26	0.50	0.01	0.024	0.034
D-1	0.14	0.50	0.21	0.022	0.032

[a] Cut from dome segment.
[b] Cut from bottom shell course.

Steels D and D-1 afford a comparison of steel which showed good life (D) and one which at the same mill showed rapid corrosion (D-1). The effect of silicon content is very apparent in these two steels. Other than a low silicon content the steels which showed a high degree of corrosion resistance to the kraft process were high in oxygen. Analysis of a steel for oxygen requires special techniques, however, metallographic examination (*4*) will usually indicate whether a steel is killed or contains appreciable oxygen and/or oxide. Figures 9 and 10 are micrographs which show the high oxygen areas in steels A and C. In contrast the appearance of the killed steel D-1 is shown in Fig. 11.

CONCLUSIONS

As a result of the test program and examination of several digester steels representative of good and poor life some conclusions regarding corrosion of mild steel in the sulphate process can be drawn.

1. Silicon is detrimental. From about 0.20 to 0.84% silicon the corrosion rate is directly proportional to the silicon content.

2. In low silicon (0.10% or less) semikilled or rimmed steels a high oxygen content imparts additional corrosion resistance.

3. Welds which contain high total silicon will corrode preferentially. This may take place as general corrosion due to alloyed silicon or as pitting caused by highly siliceous slag. This pitting is severe in some submerged arc welds where the coarse-grained deposit tends to give continuous silicate inclusions.

4. Hot-rolled steel with no special surface preparation shows good corrosion resistance. Surface preparation which removes the oxide scale or an annealing heat treatment which gives a coarse or spheroidized pearlitic structure for the steel increases the corrosion rate.

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Received Feb. 13, 1951. Presented at the annual meeting of the Technical Association of the Pulp and Paper Industry, New York, N. Y., Feb. 19–22, 1951.

Developments in Bleaching Processes

HANS WILHELM GIERTZ

The present status of the chemistry of bleaching is reviewed. Bleaching operations are considered to be primarily a continued dissolution of the lignin. Special attention is given to the chlorination process and the final bleaching with chlorine dioxide. The statement is made that during chlorite bleaching the bleaching agent is not the chlorite itself, but the liberated chlorine dioxide. Multistage bleaching and suitable prebleaching systems for kraft pulps, when the final bleaching is performed with chlorine dioxide, are discussed. The difference between sulphite and sulphate pulps and the effect of the cooking upon the degree of condensation of the lignin and thus on the bleachability is also described.

The chief object of bleaching is to remove the incrusting substances which cause discoloration, and thus obtain a pure white product. The colored impurities in sulphite pulp appear to consist entirely of lignin compounds (*6*, *9*); the dark brown color of sulphate pulp may also be due to sulphur-containing lignin products formed during the cook by condensation (*17*, *28a*).

The bleaching process can be most closely considered as a continued pulping in which it is a matter of converting the lignin products into water-soluble form. This process must be carried out as gently as possible so that the carbohydrate is not attacked; if it were, the strength would be decreased in the case of paper pulp, while the rayon pulp would show irregular decreases in viscosity and in α-cellulose content.

A prevailing tendency in the development of bleaching technique has therefore been either to adapt the bleaching conditions in such a way that the attack on the cellulose constituents is minimized, or to introduce new bleaching agents with such properties that only the lignin compounds, and if necessary other discoloring incrustations, are attacked while the cellulosic material is left intact. The transition to a preliminary bleaching through acidic chlorination followed by an alkaline extraction process, and the introduction of buffered hypochlorite bleaching and final bleaching with the new bleaching agents sodium chlorite and chlorine dioxide are examples of this.

The investigations on the bleaching process which have been carried out during the previous years at the Swedish Forest Product Laboratories had the main object to find out intensive but delicate prebleaching conditions and to study the final bleaching with chemicals of mild nature. Therefore, this paper will essentially deal with investigations on the chlorination process and the final bleaching with chlorine dioxide.

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CHLORINATION

It is a common knowledge that the reaction between chlorine and unbleached pulp is very rapid in the beginning, but thereafter comes a stage when it is markedly slowed down and the consumption of chlorine is very slow. It has long been explained that during chlorination two reactions take place with entirely different velocities. The quicker one, which dominates in the beginning, is considered to be a process of substitution and the slower one of oxidation (*37*). This has been proved by Carmody and Mears who have studied these reactions from the kinetic point of view (*3*).

Many investigations have been carried out to determine quantitatively how chlorine actually reacts. Newer investigations show that four fifths to three fifths of the total amount of chlorine is used in substitution and the rest in oxidation (*7*, *14*, *21*, *22*).

It seems to be of special interest to investigate the correlation between the dissolution of the lignin during chlorination and the chlorine consumption as distributed between the substitution and oxidation reactions.

The course of chlorination as seen from the above point of view is depicted in Fig. 1, which concerns a sulphite pulp. The major part of chlorine is consumed within 5 minutes. The consumption of chlorine is divided into two parts, i.e. (1) the substitution part and (2) the oxidation part. Substitutively the chlorine reacts extremely rapidly. This reaction is finished after about 15 minutes. The oxidation proceeds with constant velocity throughout the treatment with chlorine, except at the very beginning; this indicates that certain groups in the lignin are particularly easily oxidized.

The course of lignin dissolution determined as the residual lignin (*10*) in the pulp is also shown in the same figure. The above determination has been made on water-washed pulp on one hand and alkali-extracted pulp on the other. Lignin is rendered alkali-soluble by chlorination. That particular part of lignin which may be dissolved by alkali extraction is alkali-soluble already after 15 minutes of chlorination time. The dissolution after the above period is of insignificant value. This course goes quite in correspondence with

the substitution reaction. When the substitution reaction slows down, any further dissolving of lignin in alkali also ceases. If the chlorination reaction is allowed to continue, further amount of chlorine is consumed only through oxidation, and this consumption has no influence on the dissolution of the lignin.

If, however, after chlorination, the pulp is washed only with water, the quantity of lignin dissolved is far less than with alkaline washing. This is particularly true in the beginning of the chlorination process. After a long chlorination time, when the lignin has been destroyed by the oxidation reaction, the lignin chlorides also become water-soluble. In the bleaching of sulphite pulps, the chlorinating effect of chlorine, in the proper sense, and not the oxidizing effect, is therefore the decisive factor in dissolving the lignin. The time required to reach the optimum degree of substitution varies according to the type of pulp. This time is about 15 minutes for the pulps of low lignin content and up to 45 minutes for stronger pulps (*9*).

The chlorination of sulphate pulps follows a different course of reaction, in certain respects. The optimum lignin dissolution is obtained after a chlorination time of 60 to 90 minutes. Undoubtedly, the higher lignin content of the sulphate as compared with sulphite pulp requires longer time for the substitution reaction. However, there seems to be also another reason. A close study of the relation between optimum lignin dissolution and chlorine consumption, as divided between substitution and oxidation, has proved that in the case of sulphate pulps, also, the oxidation reaction is necessary to reach optimum lignin dissolution (*17*). This particular behavior distinguishes the bleaching of sulphate from that of sulphite pulps. The explanation may be that the sulphate lignin undergoes condensation to such a degree in the cooking operation that it must be broken up to a certain extent, through an oxidation attack, to render it soluble.

The difference between sulphite and sulphate pulps is more pronounced when we compare their respective solubility in water only. Eighty to ninety per cent of the lignin chlorides are water soluble in sulphite pulps whereas in sulphate pulps only 50 to 60% of lignin chlorides are water soluble, and the remaining part is soluble only in alkali.

The importance of an oxidative degradation simultaneously with true chlorination in bleaching of sulphate pulps also becomes evident in the commercial procedure proposed by MacMillan (*25*) and Sunesson (*41*), in which the pulp is first treated with hypochlorite and then chlorinated, or by Rue and Sconce (*31*, *32*), in which the pulp is chlorinated with an excess of chlorine, the latter then being converted into hypochlorite by the addition of lime. It has been proved both in the laboratory (*19*) and in mill practice, that these methods give better results than the usual chlorination method.

Chlorine water contains available chlorine both as elemental chlorine and hypochlorous acid. Of these, the chlorine acts as a chlorinating agent and the hypochlorous acid as an oxidizing agent. The more acid the solution is the greater is the concentration of elementary chlorine. The effect of the hydrogen-ion concentration in the course of chlorination has been studied among others by Hisey and Koon (*15*) who carried out a series of experiments in buffered solutions of

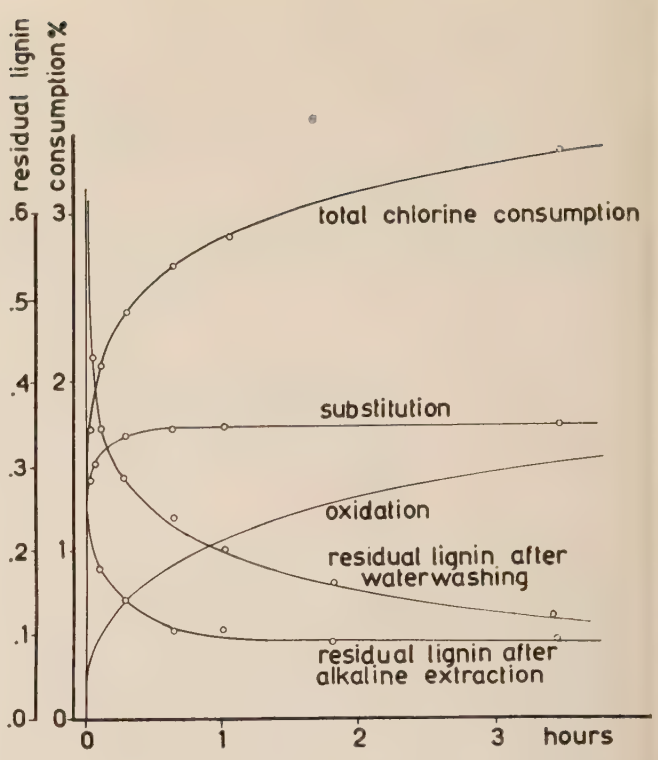

Fig. 1. The course of the chlorination of a sulphite pulp

The pulp is treated with an excess of chlorine and the chlorine consumption is determined after various times. The total consumption of chlorine is divided into two parts, viz. the substitution part, and the oxidation part. The residual lignin in the pulp is estimated (*14*) both after water-washing and alkaline extraction.

pH between 0.8 and 12.5. They proved that the reaction velocity is highest in a strongly acid medium and decreases successively with a higher pH. According to Carmody's and Mear's later calculations, which confirm results of previous investigations, the proper chlorination, followed by a certain amount of oxidation, takes place on the acid side. In alkaline solution, the chlorine acts as an oxidizing agent (*3*).

The influence of the pH of the bleaching medium upon the dissolution of lignin is shown in Fig. 2. Pronounced chlorination takes place only in strongly acid solutions. The substitution reaction decreases progressively toward higher pH and the dissolving of lignin becomes less pronounced. Oxidation dominates during alkaline bleaching, i.e., in the usual hypochlorite process. Substitution ceases at pH 7 to 9, depending upon the lignin content and the chlorine input. Since chlorination is carried out commercially in unbuffered solutions, the formation of hydrochloric acid soon causes the pH to decrease to a value of about 2 to 1.6, depending on the chlorine consumption. Thus industrial chlorination is carried out under conditions which favor substitution.

From a commercial-economy point of view the question arises as to how much chlorine should reasonably be employed in the chlorination stage, i.e., how the total demand should be distributed between chlorination and hypochlorite bleaching. The figures reported in the literature are rather divergent on this point; they indicate that 55 to 90% of the total chlorine should be in the form of elementary chlorine (*14*, *18*, *21*, *37*, *38*). Samuelsen (*34*) found for sulphite pulp, and Löschbrant (*24*) for sulphate pulp, that the maximum whiteness was obtained when the chlorine was so dis-

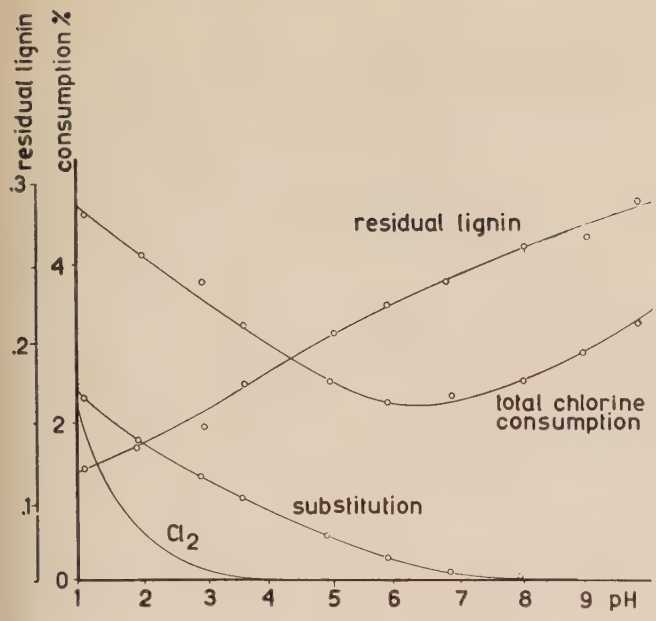

Fig. 2. Chlorination at varying pH

A sulphite pulp is treated for 1 hour with chlorine-water solutions buffered to certain pH's. The total chlorine consumption, the chlorine consumed by substitution, and the residual lignin content after alkaline extraction have been determined.

tributed that the maximum possible solution of incrusting materials took place during the substitution phase. The quantity of chlorine required for the hypochlorite stage was determined individually for each case.

The influence of the chlorine input, particularly on the dissolution of the lignin, is illustrated in Fig. 3. As long as the chlorine is consumed quantitatively, more and more lignin is dissolved out in the subsequent alkaline wash. When at a certain chlorine dosage the chlorine consumption ceases to be quantitative, the maximum lignin dissolution has been attained simultaneously.

When small amounts of chlorine are used, it is all consumed by oxidation alone (*14*). After the optimal point for dissolution has been reached, most of the chlorine reacts by substitution. Further chlorination obviously affects only lignin which has already become soluble (*24, 40*).

When the chlorine requirements for optimal solution are calculated in the way shown in Fig. 3, it is found that unbleached sulphite pulp consumes 1.5 gram of chlorine per gram of lignin. Sulphate pulp requires somewhat more chlorine. This is true when the final bleaching is made to acquire as high a brightness as possible. It will, however, be more economical, in cases of comparatively low brightness, to put in less chlorine than what is actually necessary for obtaining the optimal result.

It is known that it is impossible to delignify pulp quantitatively in a single chlorination operation. Even with chlorine in excess, the reaction with the lignin ceases before all of the lignin has been able to react. After an alkaline wash the pulp readily takes up chlorine again in a second chlorination. The chlorination reaction here, too, proceeds rapidly but ceases before all residual lignin has been acted upon. The chlorination products must again be dissolved before it is possible to attack the residual lignin any further. This topochemical effect may be explained partly by the presumption that the chlorine molecules are unable to penetrate the native lignin or the superficial regions of chlorinated lignin, which is formed during chlorination, and partly by the manner in which the lignin is enclosed in the fiber wall, i.e., by the morphological structure of the fiber. This effect is particularly evident during acidic reactions, such as chlorination and chlorine dioxide bleaching. During hypochlorite bleaching, the effect is not so pronounced because the reaction products are continuously dissolved in the alkaline medium.

For the same pulp this limit of delignification varies according to the "activity" of the chlorine. Thus, for example, the dissolution is better at a lower pH, i.e., when the concentration of elemental chlorine is higher. The activity of the chlorine is particularly high for the chlorination with gaseous chlorine. In this case, the residual lignin content in the pulp is very low after the chlorination operation followed by an alkaline extraction (*2, 9*).

The quantity of residual lignin in the pulp after chlorination, followed by alkaline washing, is partly dependent upon the quantity of lignin in the unbleached pulp, and partly on the constitution of that lignin. The latter factor seems to be of essential influence as far as sulphite pulp is concerned. If, for example, the latter pulp is prepared in such a way that the lignin undergoes condensation in the solid phase (*18a–c*), the pulp becomes more difficult to chlorinate than normal pulp with the same lignin content. In fact, chlorine consumption is reduced, and it becomes more difficult to dissolve the lignin. Under such conditions a high degree of brightness can only be obtained by a hypochlorite bleach which is more severe than usual, and this results in greater damage to the carbohydrates (*11*). Table I gives typical figures for the quantity of residual lignin, both for pulps with various Roe numbers and for pulps cooked under various conditions. The pulps were prepared from Swedish spruce (*Picea exelsa*).

It is apparent that the residual lignin after chlorina-

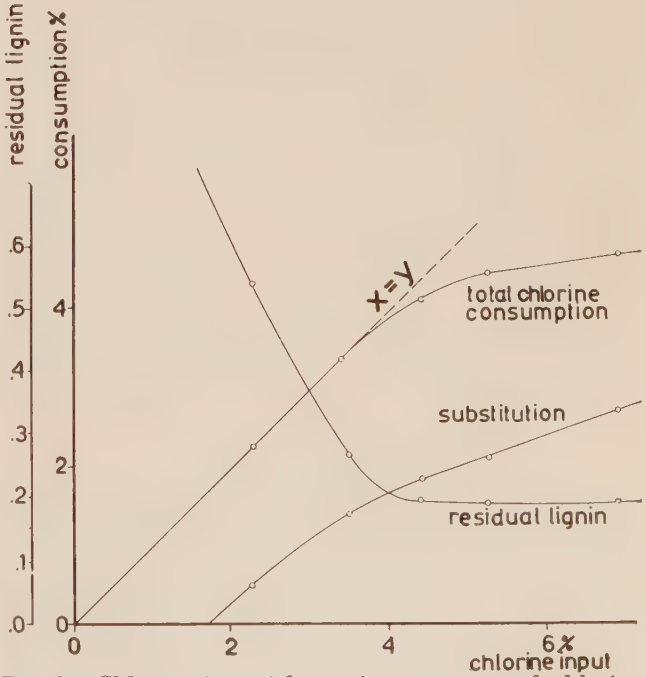

Fig. 3. Chlorination with varying amounts of chlorine

A sulphite pulp is treated for 1 hour and the residual lignin is estimated after alkaline extraction.

Table I. Influence of Cooking Conditions on Bleachability of Pulp

Cooking Conditions	Roe No.	Residual lignin (10) after chlorination and alkali wash
Cooking acid with 1.2% CaO, 5% SO_2	7.8	0.58
Good impregnation. Maximum temperature	4.2	0.24
135°C.	3.0	0.24
	1.8	0.19
	1.2	0.16
	0.6	0.13
(a) Cooking acid as above, evacuation and impregnation 39 hr. at 90°C. 3-hr. cook with maximum temperature 135°C.	2.0	0.18
(b) Cooking acid as above, impregnation 40 hr. at 20°C. 8-hr. cook with maximum temperature 135°C.	2.0	0.26
(c) Cooking acid with 0.7% CaO, 5% SO_2, no special impregnation. 8-hr. cook with maximum temperature 135°C.	2.0	0.40
Normal sulphate pulp	5.0	1.2

tion is considerably greater in the case of sulphate pulp than in that of sulphite pulp. This is explained by the fact that during sulphate cooking lignin undergoes condensation to such an extent that a good part of it cannot be dissolved by alkaline washing after chlorination. Variations in cooking conditions seem, however, not to be so important in the preparation of sulphate pulp as in that of sulphite pulp (*42*).

ALKALI EXTRACTION

The alkali extraction stage after chlorination is mainly a physical process, where temperature, alkalinity, and treatment time play the most important role. Much progress has been made regarding the removal of lignin through alkaline extraction. In modern bleaching plants, every bleaching operation, excepting the final one, is followed by alkaline washing. It has been found out that washing operations should be carried out as thoroughly as possible since the incrustations can be thus removed without attacking the cellulose.

Thorough washing with alkali is particularly important in the bleaching of sulphate pulps. Insufficient dissolving of the soluble lignin not only results in increased chlorine consumption in the subsequent steps of the process, but sometimes also makes additional treatments necessary in order to obtain the desired degree of brightness. Because of the topochemical character of the bleaching reaction, it is impossible to cause the reaction with chlorine or hypochlorite to go as far after an incomplete washing as after an effective one. The historical development of the bleaching process reveals, therefore, that more and more importance is being assigned to the alkaline washing step. The latter is sometimes accompanied by a soaking step with hot or cold water (*29*, *39*).

HYPOCHLORITE BLEACHING

Hypochlorite bleaching is also a topochemical reaction. The velocity of the reaction is great at first, but decreases before all the lignin has reacted (*28*). The reaction products are, however, soluble in alkali, and are therefore removed from the fiber continuously. The bleaching agent, therefore, continually comes in contact with fresh lignin, and if the treatment is continued for a long enough time, a fiber completely free of lignin is finally obtained. This then constitutes a fundamental difference between acid chlorination and alkaline hypochlorite bleaching.

From a technical point of view, the reaction of the hypochlorite with the residual lignin is not of the same interest as its reaction with the carbohydrates of the pulp. If the action of the hypochlorite is prolonged, the fibers may be appreciably attacked, unless proper countermeasures are taken.

It is well known that a certain amount of attack on the cellulose chains always occurs during hypochlorite bleaching, no matter what the pH. This is reflected in a gradual decrease in the degree of polymerization of the cellulose. The speed of this degradation, however, depends very much upon the pH of the solution. It is greatest in neutral solution, and decreases on both the acid and the alkaline sides of the neutral point (*5*). At the beginning of the bleach, the unbuffered solution is alkaline (pH $\sim$ 9), but because of the formation of hydrochloric acid, carbon dioxide, and other acid degradation products, the pH decreases to 6–7 (*4*, *33*). Under these conditions the bleaching proceeds rapidly, to be sure, but at a pH where the cellulose is easily attacked. Opfermann (*27*) has therefore proposed adding alkali at the beginning of the bleach, so that the liquor will remain alkaline throughout the process. This will be referred to as "buffered bleaching." The bleaching then proceeds more slowly, but the conditions for dissolving the lignin are more favorable, as has been explained above. With buffered bleaching the oxidative degradation is repressed in favor of the dissolving of the lignin; and the bleaching is carried out under conditions which spare the cellulose. The use of buffered bleaching has now become quite general, and only in cases where a short bleaching time is required is the process carried out in neutral solution.

Even if in this manner the hypochlorite bleaching is carried out under controlled pH and temperature conditions, the most serious attack during the whole bleaching process takes place in this stage. When bleaching to a very high degree of whiteness, this attack will result in a decrease of the quality of the pulp.

BLEACHING WITH CHLORINE DIOXIDE AND CHLORITES

The fundamental investigations of Schmidt (*35*) revealed that chlorine dioxide has special properties as a delignifying agent for wood which make it possible to obtain very high yields of lignin-free fibrous material. For this reason, chlorine dioxide was early proposed as a bleaching agent (*12*). The technical application of this agent, however, began only recently.

Chlorite and chlorine dioxide bleaching are very much alike. In both cases, the bleaching medium, after some time of bleaching, contains chlorite as well as chlorine dioxide and in both cases, the bleaching proceeds to give the highest possible brightness without any deteriorating influence upon the cellulose. However, the increasing tendency in Scandinavian countries is, mostly for economical reasons, toward chlorine dioxide bleaching.

The bleaching action of a chlorite solution takes place only under certain conditions. Thus for example, no bleaching effect can be observed in alkaline or neutral media. In order to produce the bleaching effect, the chlorite solution must be "activated" first, which is

done by acidification and elevation of temperature (*44*), or through the addition of oxidizing (*1, 43, 44, 45*), or possibly certain reducing agents (*13*). Every one of these operations implies that chlorine dioxide is generated from the chlorite solution. Therefore, it could be concluded that the chlorine dioxide which is developed during chlorite bleaching is the bleaching agent and so chlorite bleaching would be nothing else but chlorine dioxide bleaching.

It can be shown, however, that when bleaching is carried out in a weakly acidic medium, chlorite is consumed more rapidly than chlorine dioxide is evolved from a corresponding pure chlorite solution.

Therefore, White, Taylor, and Vincent conclude that chlorite as such reacts with pulp and thereby causes bleaching (*46, 47*). This question being of great importance, we have made detailed investigations on the subject.

Schmidt has shown that there is a particular reaction tendency of chlorine dioxide towards aromatic compounds (*35, 36*). Primarily highly colored quinoid compounds are obtained, but the reaction proceeds further, and finally the aromatic ring is converted into carbonic, oxalic, maleic, or formic acids. The same thing is true for different isolated lignin compounds, whereas chlorine dioxide does not react with alcohols and carbohydrates (*8*).

Chlorite solutions do not show the same reaction tendency toward organic compounds as does chlorine dioxide. A weakly acidified chlorite solution does not react with phenol and cresols and only slowly with quinone-forming phenols or with such lignified materials as sawdust, isolated lignosulphonic acid, and alkalilignin (*8*). From these model experiments we have concluded that chlorite as such cannot react with lignin compounds in unbleached pulp and therefore does not affect bleaching.

Acid chlorite solutions rapidly form chlorine dioxide in the presence of aldehydes, but not of ketones (*47*). The reaction of formaldehyde and chlorite at first yields hypochlorous acid which reacts with more chlorite to give chlorine dioxide (*8*). Glucose and other reducing sugars are oxidized to the corresponding aldonic acids (*20*). Aldehyde groups in the cellulose are also oxidized to carboxylic groups. When a fully bleached lignin-free pulp is treated with a chlorite solution, chlorine dioxide is produced (*8*).

These reactions provide us with an explanation of the bleaching effect exerted by an acid chlorite solution.

Chlorous acid reacts with the aldehyde groups of the pulp in the beginning of the bleaching reaction, whereby chlorine dioxide is produced secondarily. The chlorine dioxide thereafter reacts with the lignin component of the pulp. Now, intermediate products are formed which, to a certain extent, react with the chlorous acid, again resulting in the formation of chlorine dioxide. In this way bleaching continues. According to our investigations, there is nothing to point out that chlorite, by itself, causes bleaching; thus the entire bleaching effect can be ascribed to the chlorine dioxide developed from chlorite.

Bleaching with chlorine dioxide can be performed in acidic, neutral, and alkaline media. Acid bleaching brings into play the entire oxidizing capacity of chlorine dioxide, whereas with alkaline bleaching only one fifth of this capacity is used up because the reduction stops at the oxidation stage of chlorite (*26*). Bleaching in this latter way is very powerful. High brightness is easily obtained, but a certain amount of attack on the carbohydrate components of the cellulose ensues. The chlorite which is formed can be used in another stage for chlorite bleaching (*26*). The pH goes down to about 4 in unbuffered solutions, on account of the formation of hydrochloric acid and acid reaction products. In this case the course is almost the same as in acid bleaching.

During acid bleaching, the consumption of chlorine dioxide is particularly rapid in the beginning. After only a few minutes, most of the chlorine dioxide which can react with the pulp has already been consumed. However, a corresponding increase in the brightness of the pulp does not occur simultaneously with this initial rapid reaction; the brightness improves only gradually, that is, as the reaction products are dissolved or further degraded to colorless products. This requires 3 to 4 hours of treatment at 50 to 60 °C. The course of bleaching with chlorine dioxide is shown in Fig. 4.

It has been emphasized repeatedly that the attack on the pulp during the bleaching depends on the oxidation potential of the bleaching agent and that this should be the reason why chlorine dioxide and chlorites do not attack the cellulose (*23, 44*). The following table gives the "effective oxidation potentials" of several systems which are used in commercial bleaching. According to this table the oxidation potential cannot, however, be the decisive factor in determining the reaction velocity, even though it is true that the bleaching agent must have a certain oxidation potential in order to oxidize the hydroxyl groups of the cellulose. Cellulose is, for example, more slowly attacked in acid chlorine solutions than in neutral or alkaline hypochlorite, although the oxidation potential of chlorine solutions is higher at the lower pH. In view of the fact that ionic reactions are not involved, but rather heterogeneous reactions between molecules, it would appear that the oxidation depends not so much upon the oxidation potentials as upon the specific reaction mechanisms. Such a conception is supported by the fact that chlorine dioxide is a particularly favorable agent because it specifically attacks lignin compounds but not carbohydrates.

	pH	*E*, *volts*	
$2Cl^- = Cl_2 + 2e$	2	−1.20	(*29*)
	5	−1.09	(*29*)
$Cl^- + 2OH^- = ClO^- + H_2O + 2e$	7	−0.93	(*29*)
	10	−0.70	(*29*)
$ClO_2^- = ClO_2 + e$	...	−0.95	(*30*)
$Cl^- + 2H_2O = ClO_2^- + 4H^+ + 4e$	...	−0.75	(*30*)

MULTISTAGE BLEACHING

It has been mentioned previously that the bleaching reaction, on account of its topochemical character, stops before the entire quantity of lignin enters the field of reaction. The bleaching must therefore be carried out in several stages to obtain a fully bleached product. Many proposals have been submitted to combine bleaching operations already known in such a way that a particular brightness and strength may be achieved in the most economical manner.

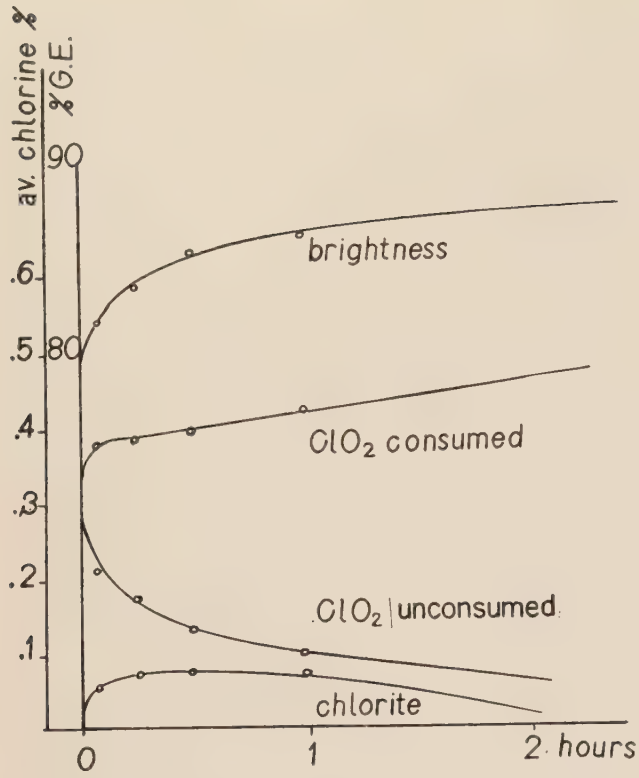

Fig. 4. The course of chlorine dioxide bleaching

A chlorinated and alkali extracted sulphite pulp is treated with 0.75% chlorine dioxide, calculated as available chlorine, at pH 4 and 60° C.

The major part of the lignin in sulphite pulps, i.e., about 90%, is dissolved through chlorination and alkaline washing. Thus the pulp is so well prebleached that it may be finally bleached in one hypochlorite stage without difficulty. This combination, i.e., chlorination – alkali washing – hypochlorite bleaching, is now the most common feature in modern sulphite bleaching plants. The introduction of one more stage is adopted in certain cases. For instance, two-stage chlorination is used for bleaching of rayon pulps. Three bleaching stages—two stages of chlorination and one hypochlorite stage or one chlorination and two hypochlorite stages—are desirable for strong paper pulps on account of their high lignin contents. This is particularly true for greaseproof pulps which on account of their characteristic high content of easily soluble carbohydrate components should not undergo an intensive alkaline treatment.

Table II. Sulphate Pulp Bleaching

Treatment	*Number of bleaching stages*	*Brightness, % GE*	*pc-value*	*Tensile strength, m.*	*Tear (Elmendorf)*	*Double folds*
Unbleached pulp	...	...	...	11,500	118	7200
Chlorination—alkaline extraction Hypochlorite bleaching	2	80.4	6.2	11,100	92	5400
Chlorination—alkaline extraction Chlorination—alkaline extraction Hypochlorite bleaching—alkaline extraction Hypochlorite bleaching	4	83.4	4.2	10,800	104	7400
Chlorination—alkaline extraction Double treatment—alkaline extraction Chlorine dioxide bleaching	3	87.0	...	10,200	109	6300
Chlorination—alkaline extraction Double treatment—alkaline extraction Chlorine dioxide—alkaline extraction Chlorine dioxide bleaching	4	89.5	1.6	11,400	117	9500

The strength figures are given according to Swedish Method CCA 17. The pc-values are a measure of the tendency of the pulp to turn yellow (*9a*).

Table II. Sulphate Pulp Bleaching

Multistep chlorination seems to be popular with the bleaching of sulphate pulps. Due to a relatively high lignin content in the sulphate pulp, after the first chlorination stage, an appreciable amount of lignin will be dissolved without impairing the strength of the pulp in the second chlorination stage. The question may, however, be raised whether the second bleaching stage, which is between the chlorination and the final hypochlorite bleaching, should be performed as a chlorination or as hypochlorite bleaching. If this second stage is carried out as acid chlorination, the chlorine, according to our investigations, predominately acts oxidatively and only slightly in a substitutive manner (*17*). According to our views, that part of the lignin which is left untouched after the first chlorination has undergone condensation to such an extent that it cannot be chlorinated at the existing low chlorine concentration. The easiest way to get rid of this residual lignin seems to be through oxidative destruction. Thus this intermediate stage should, in our opinion, be carried out as hypochlorite bleaching. This must, however, be done at a low temperature and only up to such a length of time—say 1 to $1^1/_2$ hours—that the first rapid part of the hypochlorite reaction is just completed. The reaction products should be dissolved by means of alkaline washing after each bleaching stage.

If the sulphate pulp is bleached in this manner in four stages, namely chlorination and three hypochlorite stages—with intermediate alkaline washings—a brightness of about 84% GE is achieved.

This seems to be the highest attainable limit to which it is possible to bleach a sulphate pulp by means of chlorine and hypochlorite without deteriorating the strength properties. Even now the pulp has a yellow tint. In order to obtain these optimum results, the hypochlorite stages must, however, be carried out under thoroughly controlled conditions with regard to input of chlorine, temperature, pH, and bleaching time.

To fulfill the demand for quality in the case of bleached sulphate pulp, which has increased during the last years, it has become necessary to use chlorine dioxide or perhaps chlorites for the final bleaching. On account of their topochemical effect these bleaching agents require a very well prebleached pulp. In order

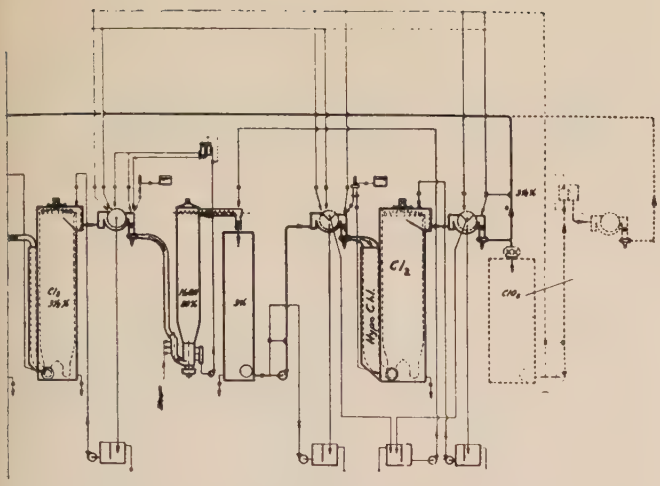

Fig. 5. Flow sheet according to Kamyr (30) for a bleaching plant with three bleaching stages: chlorination—high density alkali extraction—"double treatment"—chlorine dioxide bleaching.

to reduce the number of bleaching stages we have found it desirable to develop a bleaching system according to which it should be possible to prebleach the pulp with the minimum of equipment to such a purity that the final bleaching may be performed to produce a high brightness in one, or at the most, in two chlorine dioxide stages.

The thorough study of the above problem shows that an essential improvement in the dissolving of the lignin can only be achieved in the second bleaching stage. I have already pointed out that this stage should be carried out under strong oxidative conditions, and, in general, the bleaching agent should be given an opportunity to penetrate the fibers so as to counteract the topochemical action. With this in mind, our investigations have led us to conclude that the pulp, after the ordinary chlorination and subsequent intensive alkaline extraction, should be impregnated with an excess of hypochlorite in a second bleaching stage and, after a suitable time of reaction, be acidified. In this way, the unconsumed hypochlorite is converted into element chlorine, and the bleaching proceeds as acid chlorination. Such a "double treatment" has proved to effect a far-reaching dissolving of the lignin.

With slightly different manipulations of the "impregnation phase" with regard to the input of hypochlorite and temperature, different degrees of prebleaching are effected. Under vigorous conditions, there is a slight decrease in strength, but the pulp can be finally bleached to a brightness of 87% GE in only one stage of chlorine dioxide bleaching, whereas under mild conditions, the pulp must be finally bleached in two chlorine dioxide stages. In this latter case, there will be no attack on the strength properties of the pulp, and a very high brightness, namely of 90 to 91% GE, is obtained, the pulp thus having the extraordinary strength properties of a kraft pulp and the brightness of a highly bleached sulphite pulp.

This "double treatment" requires a proper control and it is only suitable in systems with chlorine dioxide as the final bleaching agent. It is best performed in a completely continuous system. An arrangement as outlined by Kamyr is shown in Fig. 5 (*30*).

Table II compares the bleaching of a sulphate pulp by various procedures.

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Presented at Syracuse, N. Y., May 2, 1949, sponsored by The New York State College of Forestry and the Empire State Section of the Technical Association of the Pulp and Paper Industry; presented at the Institute of Polymer Research, Polytechnic Institute of Brooklyn, May 7, 1949.

Mechano-Chemical Process—Rate of Delignification

S. I. ARONOVSKY and G. H. NELSON

Pulping rate studies were made on wheat straw with soda, kraft, and neutral sulphite pulping chemicals at 73, 83, and 93°C., in a small open vessel fitted with a high-speed stirrer. The most rapid pulping rate occurred in the first 5 minutes. Delignification continued after this period but at a greatly retarded rate. About 55% of the lignin, 30% of the pentosans, and 85% of the ash, based on the amounts of these constituents present in the original straw, were removed in the first 5 minutes; at the end of 1 hour, the amounts removed were 70, 35, and 90%, respectively. At the same concentration, caustic soda and the kraft chemicals gave practically the same degree of delignification of straw; sodium sulphite was too mild a cooking agent to produce satisfactory pulp at the low temperatures used. Both the higher cooking temperatures and the higher concentrations of cooking chemical increased the rate of pulping, the change in concentration of chemical having the greater effect. Mechano-chemical pulping of commercial straw in a 3-foot Hydrapulper gave results in good agreement with those obtained with the small laboratory vessel. It is believed that the speed and efficiency of delignification in mechano-chemical pulping are due largely to the increase, by mechanical action, in the diffusion velocities of the active chemicals and reaction products into and out of the fibrous plant material.

PULPING or delignification is essentially a surface reaction which takes place between the pulping chemical and the lignified plant tissue. The reaction proceeds rapidly at first, and then slows down as the concentration of the active chemical decreases and that of the reaction products increases in the immediate area of contact. In pulping a plant material with a dense structure, such as wood, it is necessary to force the active chemical into the wood chip before the cooking temperature is reached in order to obtain uniform pulping of the material. Otherwise, the outer portion of the chip will be completely cooked, and possibly even overcooked, while the interior is still only partially delignified. Because of less dense structure, plant materials of the grass family, such as the cereal grain straws, sugarcane bagasse, or cornstalks can be pulped practically in a relatively short cooking period without preimpregnation. Here too, however, preimpregnation shortens the cooking period still further and results in a more uniformly pulped product.

It is generally considered that diffusion is the mechanism whereby fresh active chemical is brought into contact with unreacted areas of the plant material and by which the reaction products are removed from these areas. Normal diffusion is a very slow process. A method to speed up the diffusion of the chemical to, and the reaction products from, the contact areas would, therefore, increase greatly the velocity of pulping and the uniformity of the pulp.

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The new mechano-chemical pulping process produces such results (*1*). A pulp prepared from straw by this process in $^1/_2$ hour at about 98°C. is fully equal in strength characteristics to one produced by cooking for 2 hours at 170°C. (100 p.s.i.), with the same amount of chemical, based on dry straw. The yield of mechano-chemical screened pulp (8-cut) is 6 to 8% higher than that obtained by cooking under pressure. The lignin content of the two pulps is approximately the same, but the mechano-chemical pulp contains less ash and more pentosans than the pressure-cooked product. This new process thus approaches the ideal pulping method—that is, efficient delignification with a minimum of attack on the carbohydrate portion of the cellulosic plant material.

It has been suggested that the high speed and efficiency of mechano-chemical pulping may be due largely to the increased diffusion velocities of the pulping chemicals and reaction products brought about by mechanical action in the pulping vessel. Using the Hydrapulper as the pulping vessel, the impact of the rotor vanes on the swollen straw forces out some of the liquor containing cooking chemical and reaction products. After leaving the zone of impact, the straw tends to imbibe fresh liquor to replace that which it lost. Thus the pulping vessel acts as a "pump" to force the cooking liquor into and out of the plant material. This action increases manyfold the normal diffusion rates of the chemicals and reaction products and brings fresh chemical into contact with the rapidly renewed surfaces of the plant material to be delignified. Also, some increase in surface area of the material is brought about in the pulping vessel by mechanical splitting of the larger into smaller fiber bundles.

To determine the rate of delignification in mechano-chemical pulping, a number of cooking experiments were carried out in a small laboratory vessel, using a high-speed stirrer with a rotor-propeller of special design. The time and temperature of cooking were varied, and their effects on the major constituents of the plant were studied. This report discusses the results of these experiments on wheat straw.

EXPERIMENTAL

Straw

Kawvale soft winter wheat straw, grown in the Chillicothe, Ill., area in 1945, was chosen for these studies. Only the culms or stems of this combined straw were used. They were chopped by hand into pieces $^1/_4$ to $^1/_2$ inch long. All of the nodes, heads, and other extraneous material were discarded. The chopped straw was thoroughly mixed and stored until used.

Cooking Apparatus

The cooking vessel was a 1.5-liter, stainless steel beaker (*A*, Fig. 1), covered with a loose-fitting wooden top (*B*) holding a thermometer (*C*). It was held in a

water bath (*D*) on an electric hot plate (*E*). Good temperature control was obtained in this manner. A small air stirrer with a $^3/_8$-inch shaft (*F*), fitted with a special stainless steel 3-inch propeller (*G*), was used for stirring the mixture during cooking. The propeller was a flat, circular plate with the edges of the periphery turned alternately up and down to form vanes. The speed of

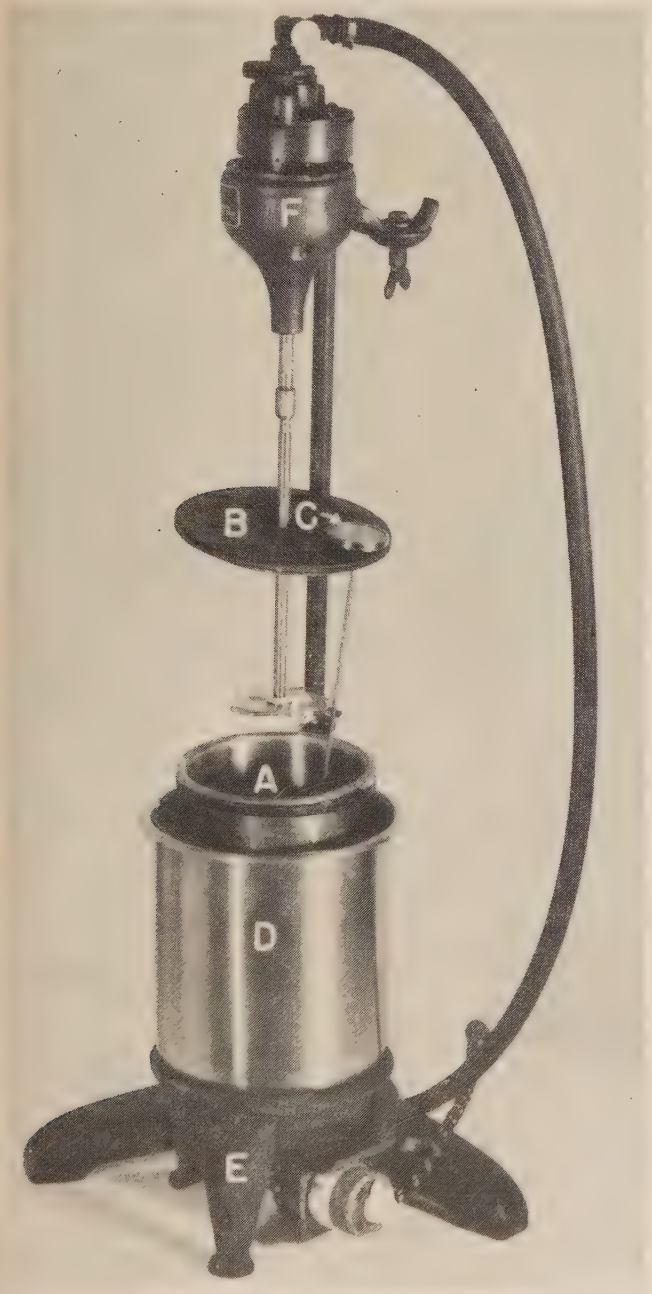

Fig. 1. Laboratory-scale cooking apparatus

this stirrer during operation was approximately 3200 r.p.m.

Pulping Procedure

A weight of the chopped straw, equal to 50 grams on the oven-dry basis, was conditioned in a wire basket over water in an oven, at the temperature to be used in cooking. The straw attained the desired tempera-

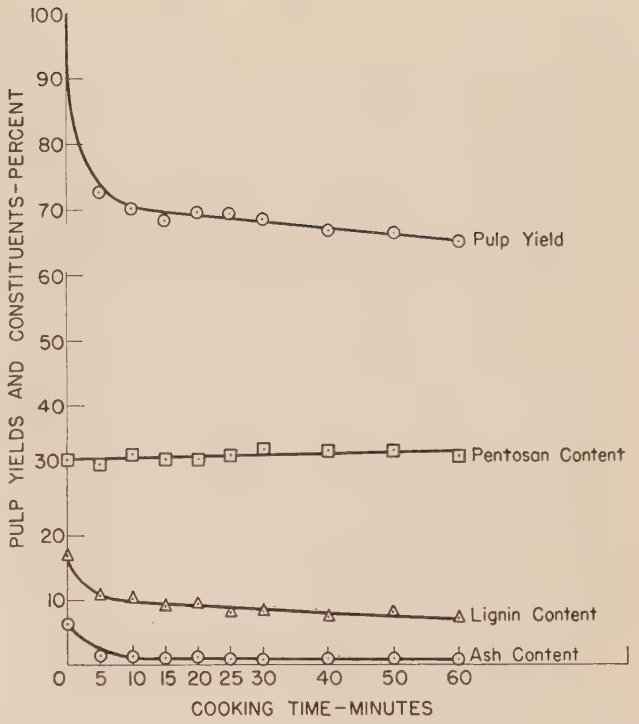

Fig. 2. Effect of time on pulp yield, lignin, pentosans, and ash contents of wheat straw cooked with 12% caustic at 93°C.

ture in $^1/_2$ to $^3/_4$ hour. The required amount of chemical and sufficient water to produce a final straw consistency of 6.6% was heated to the cooking temperature in the stainless steel vessel. Rotation of the stirrer was begun and the conditioned straw was added very rapidly, this operation requiring $^1/_2$ to 1 minute. Tim-

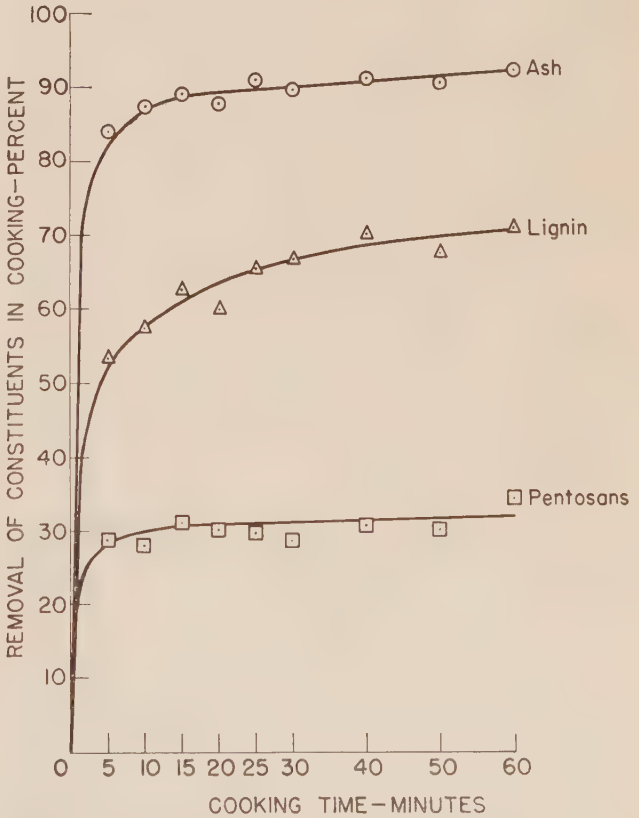

Fig. 3. Effect of time on removal of lignin, pentosans, and ash of straw in cooking with 12% NaOH at 93°C.

ing of the cooking period began when all the straw was in the vessel.

At the end of the desired cooking period, the mixture was quickly diluted with an approximately equal volume of cold, distilled water, filtered immediately through a sintered, stainless steel Buchner-type funnel, and washed free of alkali, as determined with pH indicating papers. The filtrate and washings were combined, evaporated to dryness on a steam bath, and analyzed for total solids, volatile solids, ash, lignin, and pentosans. The washed straw residue was analyzed for ash, pentosans, lignin, and permanganate number.

The cooking periods used in this study were 5, 10, 15, 20, 25, 30, 40, 50, and 60 minutes, and the temperatures were 73, 83, and 93°C. The cooking chemicals on the basis of dry straw were: 12% sodium hydroxide; 6, 9, and 12% kraft chemicals (2 parts sodium hydroxide, 1 part sodium sulphide); and 12% sodium sulphite plus 6% sodium carbonate.

The data are tabulated in Tables I and II and illustrated graphically in Figs. 2 to 11. The analyses were made in accordance with standard TAPPI methods or modifications previously described (*2*). The values given in the data are the means of at least two individual determinations in close agreement.

Table I. Effect of Time of Cooking on Yields and Constituents of Pulp and on Solids in Waste Liquor

Cook no.	Time of cooking, min.	Yield of pulp,[a] %	In the pulp				In the liquor		
			Pentosans, %	Lignin, %	Ash, %	Permanganate no.	Total solids (corrected for NaOH),[a] %	Organic matter,[a] %	Apparent loss,[a] %
Original straw	..	100.0	31.9	16.8	6.3	...	...	...	...
30	5	73.0	31.2	10.8	1.4	28.1	22.3	19.9	4.7
31	10	70.4	32.6	10.1	1.1	27.2	25.5	22.5	4.1
32	15	68.8	32.0	9.1	1.0	27.5	29.0	25.4	2.2
33	20	69.7	31.9	9.7	1.1	26.1	26.9	24.4	3.4
34	25	69.7	32.2	8.2	0.8	27.3	29.1	27.0	1.2
35	30	68.5	33.2	8.1	0.9	26.0	29.9	26.5	1.6
36	40	66.9	33.0	7.4	0.8	23.8	30.5	27.5	2.6
37	50	66.9	33.3	8.1	0.9	24.0	30.3	27.3	2.8
38	60	65.1	32.0	7.4	0.7	23.2	30.9	27.4	4.0

[a] Basis original oven-dry straw.

The cooking chemicals on the basis of dry straw were: 12% sodium hydroxide; 6, 9, and 12% kraft chemicals (2 parts sodium hydroxide, 1 part sodium sulphide); and 12% sodium sulphite plus 6% sodium carbonate.

The data are tabulated in Tables I and II and illustrated graphically in Figs. 2 to 11. The analyses were made in accordance with standard TAPPI methods or modifications previously described (*2*). The values given in the data are the means of at least two individual determinations in close agreement.

RESULTS AND DISCUSSION

The data on cooking chopped straw with 12% caustic soda at 93°C., including pulp yield, and pentosan, lignin, and ash content of the pulp, and the total solids and volatile solids (organic matter) in the liquors are given in Table I and illustrated graphically in Fig. 2. The largest loss of straw material occurred in the first 5-minute cooking period, resulting in a 73% yield of crude pulp. The drop of yield in the next 55 minutes was fairly regular and much slower, the total reduction in yield being only 8% additional for the entire period. The total solids in the waste pulping liquors and wash waters corresponded fairly well with the amount of material removed from the straw during pulping. The values in Table I for total solids were obtained by subtracting the NaOH, calculated as Na_2CO_3, used for cooking, from the total dry matter obtained by evaporating the waste pulping liquor and washings. Bearing this in mind, it may be considered that the apparent loss of total straw material in these experiments was negligible.

As indicated in Table I and Fig. 2 the rate of removal of lignin, ash, and pentosans from the straw was also greatest in the first 5 minutes of the cook. Further cooking gave only a slight lowering of the lignin and ash in the pulp. On a percentage basis, however, the pentosans in the pulp were practically unaffected by the duration of cooking. In general, the pentosan content of the pulp was approximately the same as that of the original straw, except for possibly a slight tendency to increase as cooking progressed.

Table II. Effect of Time of Cooking on Distribution of Lignin, Pentosans, and Ash in Pulp and Liquor

Cook no.	Time of cooking, min.	Lignin[a]			Pentosans[b]			Ash[c]	
		In pulp, %	In liquor, %	Loss, %	In pulp, %	In liquor, %	Loss, %	In pulp, %	Removed from pulp (by difference), %
30	5	46.7	49.6	−3.7	71.3	22.0	−6.7	16.3	83.7
31	10	42.5	62.9	+5.4	71.9	33.4	+5.3	12.3	87.7
32	15	37.1	67.1	+4.2	69.0	29.9	−1.1	11.0	89.0
33	20	40.0	68.8	+8.8	69.7	31.8	+1.5	12.2	87.8
34	25	34.1	71.0	+5.1	70.4	29.9	+0.3	8.8	91.2
35	30	33.1	68.0	+1.1	71.3	29.8	+1.1	9.8	90.2
36	40	29.6	69.8	−0.6	69.3	31.7	+1.0	8.5	91.5
37	50	32.1	68.4	+0.5	69.8	30.5	+0.3	9.6	90.4
38	60	28.8	70.5	−0.7	65.4	39.3	+4.7	7.2	92.8

[a] Basis lignin in original straw.
[b] Basis pentosans in original straw.
[c] Basis ash in original straw.

The distribution of pentosans, lignin, and ash in the residual pulp and in the waste liquors, based on the amount of these respective constituents present in the original straw, is shown in Table II, and the rate of removal of these constituents from the straw is illustrated in Fig. 3. These data show, in round figures, that 85% of the ash, 55% of the lignin, and 30% of the pentosans, originally present in the straw, were removed in the first 5-minute cooking period; in 15 minutes, the

amounts of ash, lignin, and pentosans removed were 90, 62, and 30%; in 30 minutes, 90, 65, and 30, respectively; and cooking for 60 minutes resulted in a loss of 90% ash, 70% lignin, and 35% pentosans. Practically all of the lignin and pentosans in the original straw were accounted for in the residual pulp and waste liquor as indicated by the values in Table II. No values for the

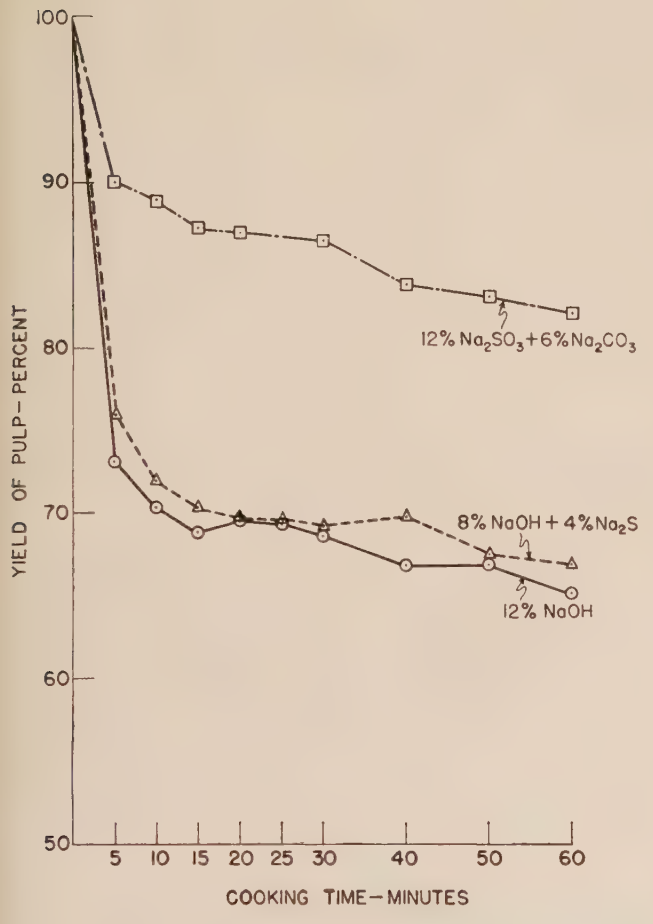

Fig. 4. Effect of type of cooking chemicals on pulp yield

portion of original straw ash present in the waste liquors of the various cooking periods are given because of the difficulty in determining the exact nature of the compounds in the liquor that represent the sodium hydroxide used for pulping.

The data indicate quite clearly that the highest degree of delignification and of ash removal occurs in the initial stages of pulping, after which these reactions continue at a considerably retarded rate. The proportion of the original pentosans remaining in the pulp was relatively high as compared with those of lignin and ash, and the rate of pentosan removal was also somewhat lower. In conjunction with the slow decrease in pulp yield, as cooking progressed, these facts serve to explain the practical constancy of the pentosan content of the pulp (Table I).

Effect of Different Pulping Agents

The relative rates of pulping or delignification with caustic soda, caustic soda plus sodium sulphate (kraft), and sodium sulphite plus sodium carbonate (neutral sulphite) are illustrated by the curves in Figs. 4 and 5.

It may be seen from Fig. 4 that the yields of crude straw pulp decreased very rapidly in the first 5 minutes of cooking, after which they continued to decrease, but at a much lower rate. It is apparent from these curves that straw is pulped by the kraft process at about the same rate as by the soda process and the pulps from both processes have, as will be shown later, fairly similar characteristics.

A satisfactory pulp could not be produced from straw by the neutral sulphite process, under the conditions used in these experiments. This is illustrated by the yield curve in Fig. 4. The extremely high yield of about 83% crude pulp, based on original straw, is of course incompatible with good delignification. That proper delignification was not obtained was also evidenced by the visual appearance of the crude cooked straw, which was fairly hard and still more or less in the original form of large fiber bundles and relatively undefibered straw pieces. When the product obtained by cooking with 12% sodium sulphite plus 6% soda ash is compared with those produced by cooking with 12% of either caustic soda or kraft chemicals, it is apparent that the neutral-sulphite pulping reagents are too mild for practical use in pulping at atmospheric pressure.

The curves in Fig. 5, showing the relative losses of lignin, pentosans, and ash from the straw, corroborate quite well the conclusion drawn from the yield data, that caustic soda and the kraft chemicals are quite comparable in their pulping action and that they are decidedly superior to the neutral-sulphite chemicals in this respect. A comparison of the curves for soda and kraft pulping shows that the actual differences between their respective rates of removal of lignin, pentosan, and ash from the straw are practically within the range

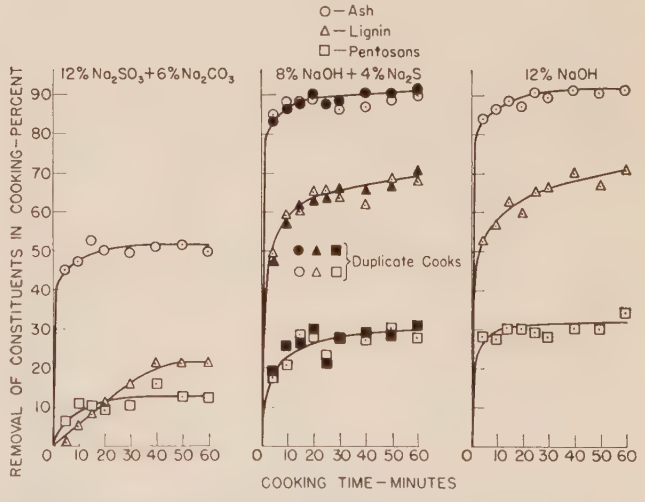

Fig. 5. Effect of type of cooking chemical on removal of lignin, pentosans, and ash from wheat straw cooked at 93°C.

of experimental error obtained in duplicate cooks with the same chemical.

The unsuitability of the neutral-sulphite process for pulping at atmospheric pressure is confirmed by the removal rate curves for lignin, pentosans, and ash in Fig. 5. It is evident that a cooked straw, still containing almost 80% of the original lignin, cannot be con-

sidered as a suitable pulp for ordinary fine paper manufacture, although it may be perfectly satisfactory for such products as corrugating paper and various grades of board materials. The fact that even with such a mild cooking agent about 50% of the original ash in the straw is removed within the first 5 minutes of cooking, supports the previously stated belief that mechanical action brings about greatly increased diffusion of the pulping chemicals and reaction products within the straw. This is also confirmed by the fact that well-cooked neutral sulphite straw pulps, produced by pressure pulping, contain more ash than the above crude pulps.

Effect of Concentration of Pulping Chemical

The effects of cooking the chopped straw with 6, 9, and 12% kraft chemicals, keeping the other pulping conditions constant, are illustrated by the curves in Fig. 6, with respect to the yields of crude pulp obtained. These yield data indicate, as expected, that the crude pulp yields decrease with the increasing amount of chemicals used. The rate of decrease in yield is greatest in the first 5-minute cooking period for all three concentrations of chemicals. For the next 10-minute period, the cooking rate with 6% kraft chemicals is considerably lower than with the 9 and 12% concentrations. After 15 minutes of cooking, the rate of decrease in yield of crude straw pulp is approximately the same for all three concentrations. The yield of crude product produced with 6% kraft chemicals was in the high range generally found satisfactory for pulps used for board products, such as corrugating paper. With 12% chemical, the crude pulp yield approached the optimum desirable for a bleachable product. The yield with 9% chemical indicated that this pulp probably was of a quality intermediate between coarse and fine pulp.

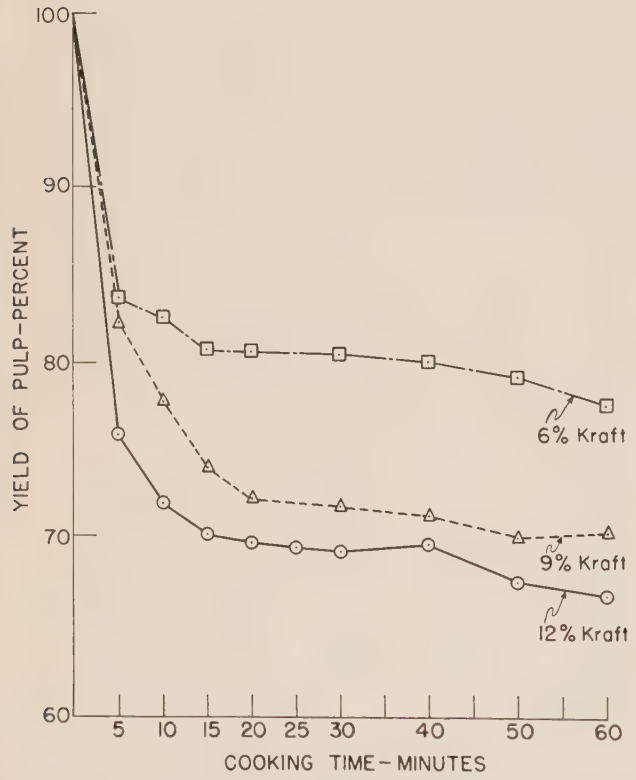

Fig. 6. Effect of concentration of kraft chemicals on pulp yields

The rates of removal of lignin, pentosans, and ash from the straw with 6, 9, and 12% kraft chemicals are illustrated in Fig. 7. Chemical concentration appeared to have the greatest effect on the rate of lignin removal.

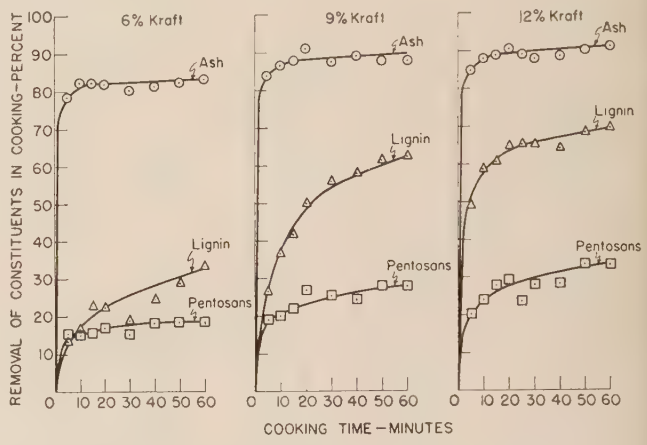

Fig. 7. Effect of concentration of kraft chemicals on removal of lignin, pentosans, and ash from wheat straw cooked at 93°C.

Delignification was fairly slow with 6% chemicals, and quite rapid when 12% kraft chemicals were used. The results with 9% chemicals were intermediate but they were closer to those obtained with the higher rather than with the lower chemical concentration. The rate of pentosan removal increased fairly regularly with increased chemical concentration, but the amounts removed were, as in the case with caustic soda, relatively small. The rate of removal of ash constituents from the straw was not greatly affected by the concentration of chemicals used for cooking, although a slightly smaller amount of these constituents was removed at the lower chemical concentration.

Effect of Temperature of Cooking

Increasing the cooking temperature from 73 to 93°C. in steps of 10°, keeping all of the other pulping conditions constant, generally gave decreased yields of crude pulp from straw, as illustrated in Fig. 8. The variation in cooking temperature had relatively little effect in the first 5 minutes of the cook, the yields of cooked pulp at 73 and 83° being practically the same and that at 93° being only slightly lower. Beyond the 5-minute cooking period, however, the crude pulp yields obtained at 83 and 93° were considerably below those found at 73°. A somewhat larger yield of pulp was obtained at 83 than at 93° in the first 10 minutes of cooking, but beyond this period the pulp yields were practically the same at both temperatures.

The rate of delignification of the straw increased as the temperature increased (Fig. 9). The largest difference in rate occurred as the temperature was raised from 73 to 83°C. Similar effects were noted in the rate of removal of ash and pentosan from the straw as the temperature was increased from 73 to 93°. Here again, as in the case with increasing concentration of cooking chemicals, the greatest effect of temperature increase was noted in the rate of lignin removal.

When the effects of increased chemical concentration are compared with those of increased temperature of cooking, it is apparent that, within the range of conditions used in these experiments, the delignification or

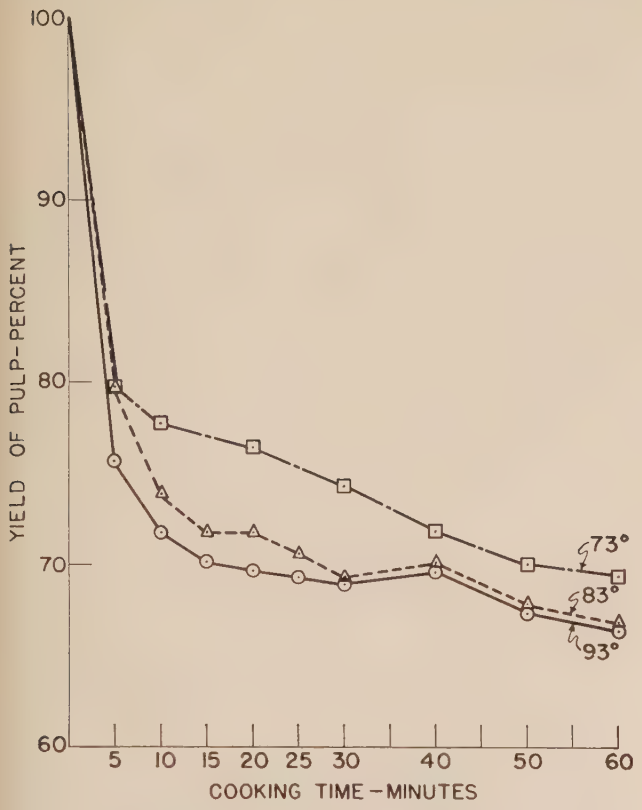

Fig. 8. Effect of temperature of cooking wheat straw with 12% kraft chemicals on pulp yields

pulping of straw is more sensitive to changes in chemical concentration than to changes in temperature.

GENERAL CONSIDERATIONS

Comparison of Small Scale and Pilot-plant Scale Cooking

To check the delignification rate studies on a larger scale, some cooks were made on regular commercial combined straw in the 3-foot, laboratory-size Hydrapulper, taking out samples for testing at various intervals throughout the run. In these larger cooks, the first samples were taken 15 minutes after the straw was added, in order to be sure that the sample taken was representative. Because of the difficulty of determining accurate yield results under these conditions, such data are not available, and consequently, neither are the removal rate curves for lignin, pentosans, and ash of these mechano-chemical pulps available. A comparison of the lignin, pentosan, and ash contents of the pulps from the laboratory-scale and pilot-plant scale runs is illustrated in the curves of Fig. 10. The results obtained with the special clean straw in the small laboratory-scale apparatus and with commercial straw in the Hydrapulper were fairly similar with regard to the lignin, pentosan, and ash contents of the respective pulps. In fact, larger scale pulping appeared to be more efficient in reducing the lignin content of the residual pulps. It is apparent from the curves in Fig. 10 that, as in the case with the small-scale laboratory operation, the rate of delignification was very rapid in the first few minutes of pulping, and then slowed down very considerably. These results point again to the fact that mechanical action in the Hydrapulper greatly increases the rate of pulping.

The strength characteristics of the pulps produced in the various time intervals of the larger scale cooks are shown in Fig. 11. All of the strength values were obtained at a freeness of 500 ml. Schopper-Riegler. It is evident from these curves that the mechano-chemical pulps have practically reached their ultimate strength values in 15 to 20 minutes' pulping with 12% caustic soda. Strength values of these pulps are at least equal to those obtained by the customary methods of cooking under pressure.

The results of these studies show clearly that the actual pulping or delignification reaction is quite rapid, particularly when caustic chemicals are used as the pulping agents. The high pulping rates are probably due mainly to the greatly increased diffusion velocities of the reacting chemicals and reaction products brought about by the rapid mechanical action of the stirrer in the laboratory apparatus and of the rotor vanes in the Hydrapulper. By this means the surfaces of the plant material to be delignified are continually cleansed from the reaction products to present fresh surfaces to the action of the pulping chemical. Fresh surfaces are also produced in the early stage of cooking by mechanical splitting of the larger into smaller fiber bundles. It thus appears possible to produce a pulp from plant materials in a matter of minutes rather than the hours usually required for producing a suitable papermaking product.

The mechano-chemical process provides a practical commercial method for such rapid pulping of plant material for papermaking. This process is particularly suitable with plant materials of the grass family where the fibrous walls are neither too thick nor too dense. It is not suitable for materials such as wood with a dense structure not readily permeable to rapid perfusion of liquids even under pressure. Cereal grain straws, sugarcane bagasse, cornstalks and similar materials, on the other hand, have thin walls, with relatively open structure as compared with wood, thus allowing for fairly good flow of liquid through the material.

This new process is suitable only with the strong types of caustic chemicals or other pulping agents. As

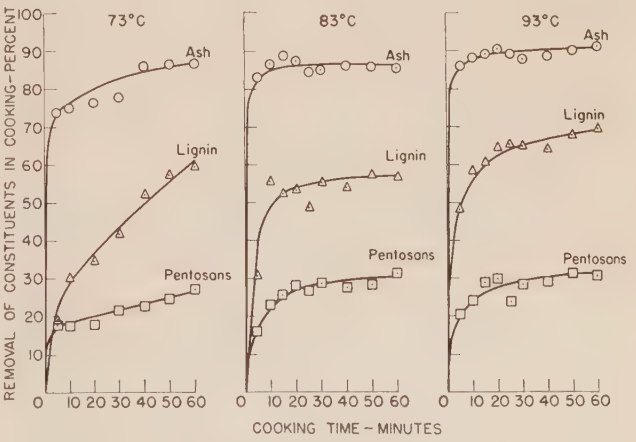

Fig. 9. Effect of temperature on removal of lignin, pentosans, and ash from wheat straw cooked with 12% kraft

shown earlier in this report, this process does not work satisfactorily with a mild pulping agent such as sodium sulphite which is an active delignifying agent only at higher temperatures than can be obtained at atmospheric pressure in an open vessel. It is evident, of course, that even at the temperatures prevailing in mechano-chemical pulping, a suitable pulp could be produced by cooking long enough with sodium sulphite, but this operation would not be practical. In the early work on this new process, some pulps were made by cooking straw with lime as the sole or major ingredient. From the standpoint of producing a pulp for corrugating paper suitable for operating on the paper machines, lime could be used as the pulping agent. However, later work at the Laboratory (*3*) has shown that a considerably stronger pulp, especially with regard to crush resistance, can be produced with the use of caustic soda or sodium sulphite, with the elimination of all or most of the lime.

The better degree of delignification obtained in the 3-foot Hydrapulper, when compared with the results from the small-scale laboratory apparatus, indicates that commercial scale pulping in units 10 to 18 feet in diameter might produce even better and more rapid delignification. This has already been established in experiments on the production of a crude straw pulp for corrugating paper, where better and more rapid pulping was obtained in an 8-foot Hydrapulper than in the 3-foot laboratory unit, and still better results in an 11-foot commercial Hydrapulper. It is thus evident,

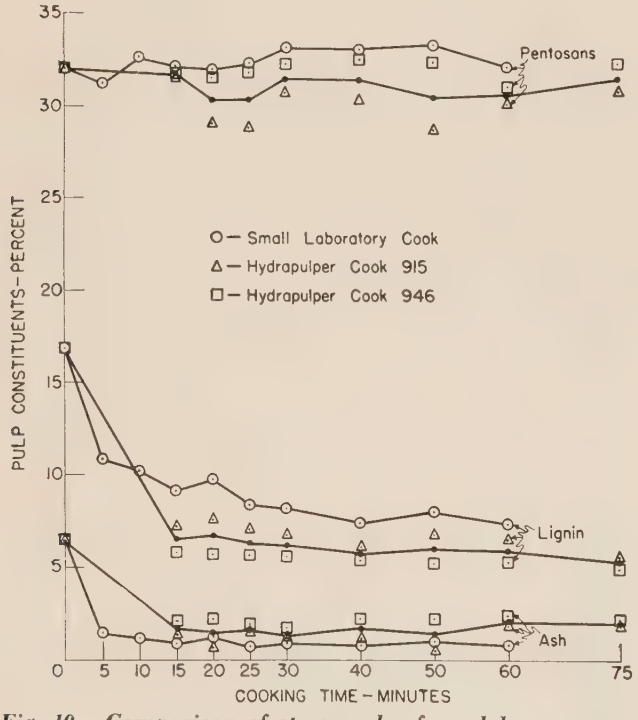

Fig. 10. Comparison of straw pulps from laboratory apparatus and Hydrapulper in cooking with 12% caustic at 93 to 98°C.

from these studies on rate of delignification, that the new mechano-chemical process provides a means for the rapid and efficient production of pulp from plant materials of the grass family by greatly increasing the velocity of diffusion of the chemical reactants and reaction products through the plant materials during the cooking.

SUMMARY AND CONCLUSIONS

1. Studies of pulping rates were made, on clean, chaff-free, node-free wheat straw, using soda, kraft, and neutral sulphite pulping chemicals. The cooking experiments were carried out at 73 to 93°C. for 5 to 60 minutes in a small open vessel equipped with a high-speed stirrer.

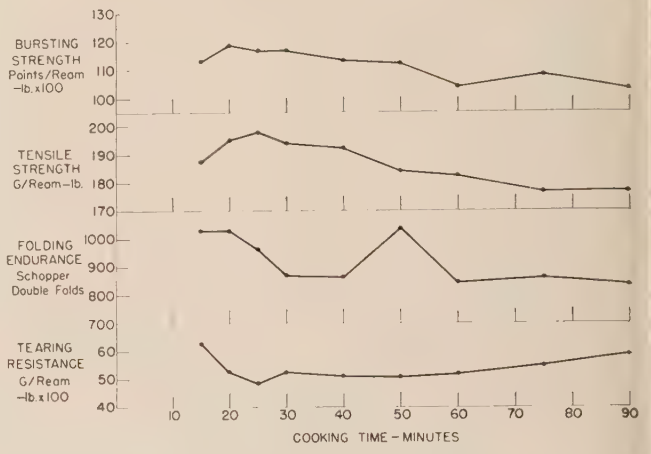
BURSTING STRENGTH Points/Ream –lb. x100
TENSILE STRENGTH G/Ream–lb.
FOLDING ENDURANCE Schopper Double Folds
TEARING RESISTANCE G/Ream –lb x100
COOKING TIME – MINUTES

Fig. 11. Strength characteristics of mechano-chemical pulps from straw cooked with 12% caustic for various time intervals at 93 to 98°C.

2. The highest degree of pulping or delignification took place in the first 5 minutes of cooking, after which delignification continued at a greatly retarded rate. Based on the amounts of the constituents present in the original straw, 55% of the lignin, 30% of the pentosans, and 85% of the ash were removed in the first 5 minutes, and 70, 35, and 90%, respectively, in 1 hour.

3. Pulping with caustic soda and with kraft chemicals gave similar results in rate and degree of delignification; sodium sulphite is too mild an agent to produce satisfactory pulps at the low temperatures used.

4. Increased concentration of cooking chemical and the higher cooking temperatures increased the pulping rate, with changes in chemical concentration having the larger effect.

5. Results obtained from mechano-chemical pulping of commercial straw in a 3-foot Hydrapulper were in good agreement with those from the small-scale laboratory apparatus.

6. It may be concluded that the speed and efficiency of delignification in the mechano-chemical process is probably due largely to the increase in diffusion velocities of the active chemicals and reaction products into and out of the fibrous plant material, and also to mechanical reduction of the larger into smaller fiber bundles.

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Received Feb. 14, 1950. Presented at the Annual Meeting of the Technical Association of the Pulp and Paper Industry, New York, N. Y., Feb. 19–22, 1951.

The authors gratefully acknowledge the assistance of L. E. Talley and E. G. Helman of the Pulp and Paper Section, Agricultural Residues Division, Northern Regional Research Laboratory, in carrying out these cooking studies and in making the necessary analyses.

The Influence of Temperature During the Beating Process

O. K. RONNING and C. E. LIBBY

Strong unbleached sulphite pulp was beaten in a Noble and Wood laboratory beater at various temperatures (5 to 80°C.). Experiments carried out at 4% consistency on pulp added to the beater in the form of wet laps indicated that a gradual increase in beating time was necessary to reach a given freeness value as the temperature of beating was increased. The relationship between freeness and drainage time was found to be influenced by the beating temperature in such a way that the drainage time corresponding to a given freeness was decreased as the temperature was increased. Initial greaseproofness occurred at a lower drainage time when the beating temperature was lowered. The best average strength properties of the handsheets resulted from moderately high beating temperatures. Corresponding beater runs made at 2.5% consistency proved that a longer beating time was necessary to reach a given drainage time. When the pulp was added to the beater in an air-dry condition, the shortest beating time did not appear at the lowest, but at an intermediate temperature. Compared with similar runs starting with wet pulp the necessary beating time was increased for all temperatures when air-dry pulp was employed. The appearance of the greaseproof point was greatly delayed when air-dry pulp was beaten. Burst and tensile strength values were considerably lower while the tear and bulk values were higher. Limited investigations were made concerning the influence of surface tension of the beater water on the beating time.

LIKE other processes in the manufacture of paper, the beating process has its quota of variables which must be controlled in order to develop the desired qualities of the paper with a minimum expenditure of money. One of these variables is the temperature of beating which specifically refers to the temperature of the pulp in water suspension during the beating period. This factor is usually difficult to vary and control in a commercial beating operation and is often given very little attention. Nevertheless it plays an important role and should not be neglected in establishing the optimum conditions for the stock preparation in the manufacture of certain types of paper.

Ordinarily the stock for most paper grades will not show any appreciable increase in temperature during the beating process. However, pulp which must be beaten to a low freeness, as in the production of glassine paper, and also stock difficult to beat down, such as strong sulphate and rag stock, will accumulate a great amount of heat during the long beating period which usually is necessary. In some cases it has not been uncommon to find temperatures of the pulp as high as 60 to 70°C. at the end of the beating process.

The fact that hot beating generally slows down the beating process has long been known to the papermaker from practical experience. This result has also been shown by several investigators who have worked in this field. Whether or not these high temperatures have any degrading effect on the quality of the stock has not been fully established.

The first known attack on the temperature problem was made in 1916 by Stephenson (*15*) at the University of Maine. Sulphite pulp was beaten at 23, 50, and 63°C. and the conclusion was made that increased beating temperature decreased the strength properties of the resulting paper. All tests were made after 5 hours of beating, i.e., probably at different freenesses. From mill experience Hatch (*4*) reported that the strength properties of the finished paper were lower in the summer time than in the winter time which he thought was due to the change in temperature of the incoming river water. A refrigeration system was installed and the variation in strength properties disappeared. Sindall and Bacon (*14*) found that low temperature in the beater favored the production of what they termed "wet" stuff and Jenkins (*5*) stated that dehydration took place when the stock was heated in the beater. The same was found by Milne (*9*) and also Strachan (*16*) who observed that dehydration up to about 40°C. was not very pronounced. He therefore suggested in view of the fact that heating assists in expulsion of air, that a moderate temperature might be permitted during the beating process. Clark (*1*) stated, from experiments performed with his laboratory kollergang, that temperatures within the normal range probably had little effect on the strength properties. Hall (*2*) investigated by means of an improved Lampén mill the influence of temperature (6 to 30°C.) on the beating time and the strength properties of kraft pulp. He drew the conclusion from his studies that the temperature of the water does not have any bearing on the character of the beating (strength properties), but only on its speed. An extensive and very valuable study was made by Lewis and Gilbertson (*7*) at The Institute of Paper Chemistry. The experiments were carried out on rag stock at temperatures from 6 to 85°C. by means of a temperature-controlled Noble and Wood laboratory beater. The results indicated that the rate of beating was somewhat faster at 25°C. than at either 6 or 45°C., while the slowest beating of all took place at the highest temperatures. Handsheets made from the stock beaten at low temperatures showed higher fold, tear, burst, and tensile strength than sheets made from stock beaten at high temperatures, compared at the same freeness. The work also seemed to indicate that the rate of beating was controlled by the temperature in the beater during the first half of the beating period, while the strength characteristics of the handsheets seemed to be determined by the temperature during the last half of the beating period. Chemical constants, such as alpha-cellulose content, copper number, and cuprammonium

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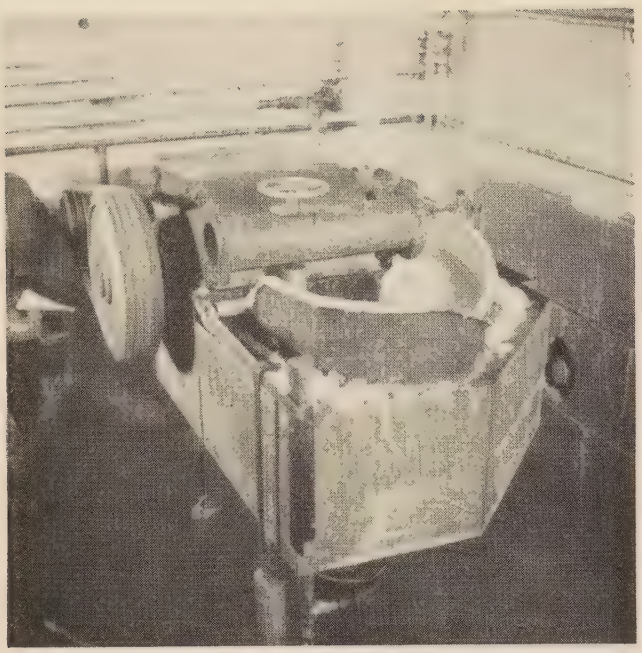

Fig. 1. Laboratory beater with jacket for temperature control

viscosity were found to be unaltered either by time or temperature. Another important contribution in this field has been made by Noll (*11*). He used a Clark kollergang with a ringburner underneath and investigated bleached and unbleached sulphite pulps, with both high and low beating resistance. His results showed that all four types of pulp required a distinct increase in beating time to develop an equal freeness when a beating temperature of 50°C. was used compared with beating at 20°C. All the physical properties of the handsheets showed lower values for pulp beaten at high temperature over the whole range of beating times. He suggested the theory that the change in surface tension of the beating fluid with variation of the temperature is the reason for the difference in the beating time necessary to reach a certain freeness. To prove this, he carried out beating experiments at constant temperatures with a wetting agent added to the distilled water and found that the necessary beating time was considerably longer. When the surface tension was increased (beating in a 25% NaCl solution), a decrease in beating time was noted. In his later work (*12*), carried out on a commercial scale, his previous finding concerning beating time was verified, but the strength properties of the finished machine-made paper turned out to be almost identical with cold beating (2.5 to 15°C.) and beating without cooling (19 to 34°C.).

A general summary of these previous investigations dealing with the temperature problem shows an all-over agreement that a high temperature in the beater will increase the time to reach a certain freeness. It was not established whether or not the lowest temperature will give the shortest beating time. Regarding the influence on the strength characteristics of the resulting paper there seemed to be certain disagreements among the investigators. It was therefore felt that a further attack on the temperature problem was justified. In the work here reported, an attempt has been made to find a possible reason for some of these disagreements and to develop additional information on the beating temperature problem. In particular, the behavior of air-dry pulp has been investigated in this connection, compared with pulp which has never been allowed to dry, and also to some extent the influence of a variation in pulp consistency has been determined.

BEATER FURNISH

An indirect cooked unbleached sulphite spruce pulp from a Midwestern mill was used in all the beater runs. The bales were taken from the same mill cook and had an average moisture content of 65%. The pulp was added to the beater either in this moist condition or air dried. Laboratory processing of the pulp (TAPPI Standard T 200 m-45) showed a beating time of 37.5 minutes to reach a freeness of 125 ml. Canadian Standard. At this stage the burst factor was 54.5, breaking length 9350 meters, and the tear factor 37.5 (metric units). The chemical analysis showed a permanganate number of 12.2, copper number of 1.95, pentosan content of 5.3%, alpha-cellulose content of 83.4%, and a total pitch content of 3.74% with ratio 42 to 100 of ether solubility to alcohol solubility.

As the beating medium distilled water was used which had a pH of 5.5.

EXPERIMENTAL EQUIPMENT AND PROCEDURES

Beating

The beater employed was a Noble and Wood cycle beater (Fig. 1). For control of temperature the beater was equipped with a jacket of galvanized iron fully surrounding the tub. Low temperatures were achieved by filling the jacket with ice or a mixture of ice and salt. This cooling medium could not keep the stock at a constant temperature much lower than 15°C. For the lowest temperature runs packing of dry ice against the walls of the tub was found necessary. The higher beating temperatures were secured by filling the jacket with water and the temperature regulated by steam injection or addition of cold water. To prevent evaporation of water in the beater at higher temperatures the tub was equipped with a tight fitting iron cover. The inner walls of the beater were painted with a high-temperature resistant paint. This beater had a capacity of 2 to 10 pounds, depending upon the consistency. The diameter of the beater roll was 15 inches and the width 12 inches. The 36 fly bars, each $^{5}/_{16}$ inch thick, were made of bronze, as were the 16 bedplate bars, each with a thickness of $^{5}/_{32}$ inch, arranged in a 10° herringbone pattern. The speed of the beater roll was main-

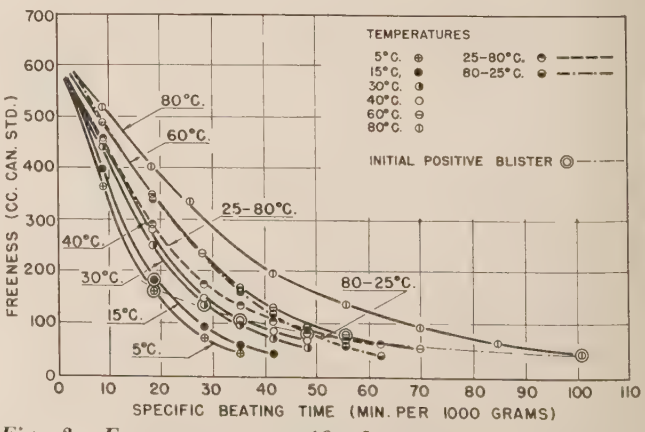

Fig. 2. Freeness vs. specific beating time. 4% consistency. Wet pulp furnish

tained constant at 480 r.p.m. A lever system made it possible to keep a constant pressure between the roll and bedplate. This pressure was kept at 1.2 kg. per cm. throughout the entire investigation giving a mild treatment to the fibers. Through test runs it was found that the circulation of stock was maintained satisfactorily up to a maximum of 4% consistency. As it was desired to make the beating conditions approximate those of the average beating operation in a paper mill, this maximum consistency was chosen for the major part of the investigation.

The beating procedure was carried out in the following manner: after the surrounding jacket had been filled with the heating or cooling medium, enough distilled water was added to give a final stock volume of 80 liters. The water was circulated with the roll in the breaking position until the desired temperature was established through the entire system. Then the calculated amount of pulp (3200 grams moisture-free for runs at 4% consistency), was added to the beater over a period of 10 minutes with the roll still in the raised position. After an additional 5 minutes of breaking action, the first pulp sample, designated as the starting unbeaten pulp, was removed and the roll was lowered and a constant pressure applied (zero time). Additional samples for testing were removed after 30, 60, 90, 110, 130, 150 minutes, and so on, until a freeness of 75 to 50 ml. Canadian Standard was reached. Each test sample consisted of 1350 ml. of stock.

Pulp Testing, Sheetmaking, and Sheet Testing

Freeness tests were made on each pulp sample using a Green freeness tester (TAPPI Standard T 227 m-46). A Bauer classifier with screens of 20, 35, 65, and 150 mesh was used in cases where a fiber classification test was conducted. The test sheets, seven from each pulp sample, were made on a British standard sheet mold (T 205 m-45). Drainage time was recorded on all sheets and an average taken (T 221 m-42). The physical testing was carried out according to T 220 m-46. Each pulp sample had made on it 12 tests for bursting strength (Perkin's Mullen Tester, motor driven), 12 tests for tensile strength and stretch (Thwing-Albert Electro-Hydraulic Tensile Tester), 6 for folding endurance (Schopper-Riegler Folding Tester), and 10 for thickness. In addition to this, the greaseproofness of the handsheets was determined using the blister test. Transparency determinations (Higgins' Photo-Electric Colorimeter) were made for some of the beater runs.

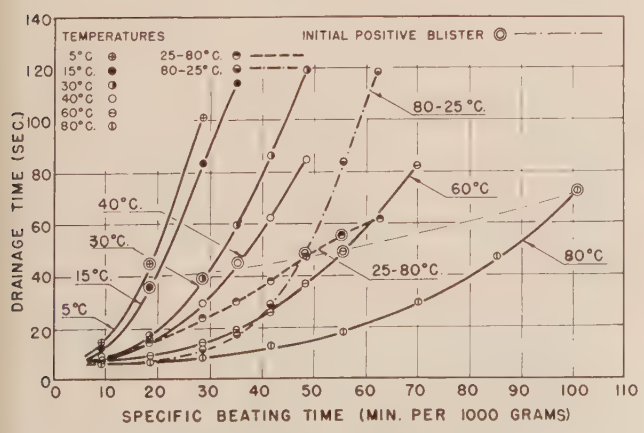

Fig. 3. Drainage time vs. specific beating time. 4% consistency. Wet pulp furnish

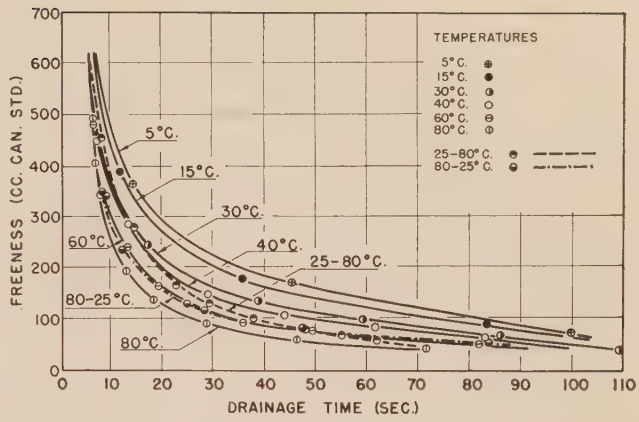

Fig. 4. Freeness vs. drainage time. 4% consistency. Wet pulp furnish

The direct results of the different tests and the derived units have been reported in the metric system. The following units are used:

Freeness: Canadian Standard in milliliters.
Drainage time: seconds.
Greaseproofness: initial positive blister, graded as "very slight," "slight," "almost definite," and "definite."
Breaking length: meters.
Stretch: per cent.
Fiber classification: per cent.
Coarse fraction: retained on no. 20 screen.
Intermediate fraction: retained on nos. 35, 65, and 150 screens.
Fine fraction: through no. 150 screen.

EXPERIMENTAL WORK

The investigation was divided into three major parts:

1. Beating at 4% consistency using wet pulp furnish (65% moisture content). The beating temperature was held constant at 5, 15, 30, 40, 60, and 80°C. A uniform increase in temperature from 25 to 80°C. and a uniform decrease from 80 to 25°C. were also employed.
2. Beating at 4% consistency using an air-dry pulp furnish. The beating temperature was held constant at 15, 30, 40, and 80°C.
3. Beating at 2.5% consistency using a wet pulp furnish at a constant temperature of 15, 40, 60, and 80°C.

It was found that duplicate beater runs checked well and only one set of values for each run is shown in the tables and graphs. All the graphical illustrations concerning beating time show the drainage time or freeness compared with what has been termed specific beating time, defined as minutes of beating per 1000 grams of pulp, rather than with the recorded beating time. This has been done to facilitate the comparison between experiments carried out at different consistencies, taking into consideration the decreasing amount of pulp in the beater due to sampling. The strength factors and other physical factors of the pulp sheets have been compared with the recorded drainage time of the pulp, which has been illustrated on a logarithmical scale to obtain the best interpretation of the results.

Beating at 4% Consistency, Wet Pulp Furnish

The more important results of this investigation are included in Table I and shown in Figs. 2 to 8.

Rate of Beating (Figs. 2 to 4). The data indicate that the rate of beating as shown by the freeness (Fig. 2) and the drainage time (Fig. 3), is most rapid at the

Table I. Beater Runs Conducted at 4% Consistency, Wet Furnish

	Beating time, min.	*Specific beating time, min./kg.*	*Drainage time, sec.*	*Freeness, ml.*	*Blister test*	*Burst factor*	*Tensile strength, meters*	*Stretch, %*	*Tear factor*
Run no. 1—Beating temp., 5 °C.	0	0	5.1	638	Neg.	46.2	8,850	1.35	51.8
	30	9.3	14.1	365	Neg.	57.3	10,240	2.16	47.3
	60	18.9	45.2	165	Slight	62.8	10,700	2.27	45.0
	90	28.6	100.0	70	Def.	63.2	10,450	2.40	40.1
	110	35.2	162.0	45	Def.	62.0			
Run no. 2—Beating temp., 15 °C.	0	0	5.7	639	Neg.	49.6	9,580	1.53	53.4
	30	9.3	11.4	397	Neg.	61.5	10,220	2.02	47.8
	60	18.9	35.3	185	Slight	65.6	11,050	2.55	43.4
	90	28.6	83.7	96	Def.	67.0	10,900	2.48	41.5
	110	35.2	114.0	57	Def.	65.3	11,000	2.82	37.4
	130	41.9	170.2	34	Def.	67.0	10,900	2.86	36.0
Run no. 3—Beating temp., 30 °C.	0	0	5.0	640	Neg.	47.7	9,100	1.64	57.5
	30	9.3	6.9	460	Neg.	58.0	9,800	2.17	55.0
	60	18.9	17.0	240	Neg.	64.5	10,650	2.45	51.7
	90	28.6	39.7	136	Slight	67.4	11,200	2.54	47.5
	110	35.2	59.3	101	Alm. def.	67.6	10,860	2.68	47.3
	130	41.9	86.0	73	Def.	68.8	11,560	3.20	47.6
	150	48.8	118.8	52	Def.	68.9	11,300	3.05	46.3
Run no. 4—Beating temp., 40 °C.	0	0	5.2	649	Neg.	49.5	9,050	1.78	62.0
	30	9.3	7.5	442	Neg.	60.8	11,100	2.46	54.6
	60	18.9	13.0	290	Neg.	65.8	11,200	2.52	52.2
	90	28.6	29.1	150	Neg.	69.3	11,500	2.74	46.3
	110	35.2	44.2	110	Slight	70.7	11,330	2.92	46.6
	130	41.9	62.1	85	Alm. def.	70.2	11,450	3.22	46.1
	150	48.8	84.3	70	Def.	71.3	11,560	3.60	...
Run no. 5—Beating temp., 60 °C.	0	0	4.9	648	Neg.	49.8	8,400	2.22	66.1
	30	9.3	6.5	482	Neg.	62.0	10,120	2.45	58.8
	60	18.9	8.7	349	Neg.	63.8	10,560	2.66	53.0
	90	28.6	13.1	241	Neg.	66.6	10,800	2.76	54.7
	110	35.2	19.7	170	Neg.	68.4	10,950	...	53.5
	130	41.9	25.0	132	Neg.	70.6	11,600	...	49.3
	150	48.8	36.1	96	V. slight	70.6	11,450	3.02	50.5
	170	55.7	49.2	80	Slight	68.4	11,510	3.07	49.2
	210	70.1	82.1	51	Alm. def.	69.6	11,470	2.81	44.6
Run no. 6—Beating temp., 80 °C.	0	0	5.1	649	Neg.	47.2	8,000	2.32	63.4
	30	9.3	5.7	524	Neg.	58.0	9,700	2.70	56.3
	60	18.9	6.9	404	Neg.	61.7	9,850	2.82	52.7
	90	28.6	8.0	341	Neg.	...	10,060	3.01	55.4
	130	41.9	12.8	197	Neg.	67.0	10,500	3.16	49.1
	170	55.7	19.2	139	Neg.	66.6	10,780	3.10	53.6
	210	70.1	28.8	94	Neg.	69.8	10,750	3.49	49.1
	250	85.0	46.1	62	V. slight	70.0	11,180	3.44	48.6
	290	100.5	71.8	47	Slight	68.0	10,900	3.45	46.7
Run no. 7—Beating temp., 25 to 80 °C.	0	0	5.2	644	Neg.	48.8	9,170	1.32	60.0
	30	9.3	7.8	455	Neg.	58.3	10,000	1.93	52.0
	60	18.9	14.4	291	Neg.	61.8	10,440	2.31	51.6
	90	28.6	22.8	174	Neg.	61.2	10,700	2.54	52.8
	110	35.2	29.0	138	Neg.	64.6	10,610	2.41	51.6
	130	41.9	38.5	106	V. slight	66.8	10,500	2.68	54.1
	150	48.8	48.2	83	V. slight	66.2	10,530	2.68	49.4
	170	55.7	54.9	73	Slight	68.0	10,580	3.78	49.5
	190	62.8	61.8	67	Alm. def.	67.7	10,620	3.44	47.0
Run no. 8—Beating temp., 80 to 25 °C.	0	0	5.1	637	Neg.	47.6	7,940	2.34	61.9
	30	9.3	6.0	489	Neg.	58.6	9,620	2.95	58.7
	60	18.9	8.1	350	Neg.	62.5	9,620	2.40	56.5
	90	28.6	12.2	240	Neg.	66.3	10,520	2.78	54.8
	110	35.2	18.9	169	Neg.	68.5	10,720	2.96	51.7
	130	41.9	28.3	124	Neg.	69.8	10,950	2.92	51.9
	150	48.8	47.7	86	V. slight	70.8	11,200	2.98	47.6
	170	55.7	83.9	60	Alm. def.	72.3	11,200	3.03	46.2
	190	62.8	118.7	46	Def.	72.0	11,320	3.75	42.8

lowest temperature, 5°C., and gradually decreases as the temperature is increased. It is also clearly evident how the beating at uniform increasing or decreasing temperature fits into the picture. The run starting at 25°C. and ending at 80°C. shows a steadily decreasing rate of beating with increasing temperature, while the run starting at 80°C. and ending at 25°C. shows that the low degree of beating during the first part of the run is rapidly improved as the temperature is lowered. Initial positive blister test, graded as "slight," is indicated on the graphs. An objective grading of the blister test is somewhat difficult to make. Furthermore, the tests were made only at whatever drainage time the test samples indicated. Therefore, the exact position of the curve for an equal degree of greaseproofness is not easily located by this method. The points indicate, however, that initial blister will occur at a higher freeness or lower drainage time as the temperature is lowered, in other words, that high-temperature beating has to be continued to a lower freeness or higher drainage time to obtain greaseproofness.

During the testing of freeness and drainage time it was found that certain variations occurred in the relationship between these two factors. Therefore, the corresponding freeness and drainage time for the different temperatures were compared with each other, as shown in Fig. 4. Here it is clearly seen that the rela-

Table II. Beater Runs Conducted at 4% Consistency, Air-Dry Furnish

	Beating time, min.	Specific beating time, min./kg.	Drainage time, sec.	Freeness, ml.	Blister test	Burst factor	Tensile strength, meters	Stretch, %	Tear factor
Run no. 9—Beating temp., 15°C.	0	0	4.7	659	Neg.	28.5	5,080	0.88	86.0
	30	9.3	5.6	575	Neg.	40.5	7,090	1.48	66.3
	60	18.9	6.7	473	Neg.	46.8	8,200	1.95	64.6
	90	28.6	9.3	374	Neg.	49.6	9,100	2.12	61.6
	110	35.2	12.3	305	Neg.	54.3	9,820	2.36	59.2
	130	41.9	14.9	264	Neg.	59.7	9,710	2.48	58.4
	150	48.8	21.5	203	Neg.	59.3	10,150	2.87	58.0
	190	62.8	36.9	138	Neg.	62.0	9,750	2.68	52.5
Run no. 10—Beating temp., 30°C.	0	0	4.9	651	Neg.	22.2	4,490	1.57	85.0
	30	9.3	6.8	480	Neg.	42.2	7,350	2.22	58.9
	60	18.9	11.8	317	Neg.	50.7	8,640	2.45	58.4
	90	28.6	23.9	182	Neg.	58.0	9,360	2.72	55.7
	130	41.9	58.3	92	Neg.	...	9,570	2.82	52.9
	170	55.7	117.0	53	V. slight	62.4	10,000	3.22	50.2
Run no. 11—Beating temp., 40°C.	0	0	4.9	655	Neg.	27.0	5,170	1.15	83.7
	30	9.3	5.9	485	Neg.	44.5	7,840	1.42	61.5
	60	18.9	7.7	362	Neg.	51.5	8,860	2.23	..
	90	28.6	10.5	248	Neg.	54.6	9,400	2.32	53.0
	110	35.2	15.1	198	Neg.	58.2	9,950	2.60	55.8
	130	41.9	20.1	151	Neg.	60.5	9,860	2.62	54.2
	150	48.8	30.7	114	Neg.	63.0	10,180	2.99	51.4
	170	55.7	47.7	81	Neg.	64.1	10,330	3.00	50.9
	190	62.8	72.6	59	Neg.	61.5	10,740	3.10	48.1
Run no. 12—Beating temp., 80°C.	0	0	4.7	647	Neg.	25.3	4,970	1.14	84.7
	30	9.3	5.3	537	Neg.	44.2	7,030	2.02	67.3
	60	18.9	6.0	460	Neg.	48.0	7,620	2.30	61.7
	90	28.6	6.8	383	Neg.	52.5	8,220	2.30	58.0
	130	41.9	7.9	314	Neg.	57.2	8,640	2.49	57.6
	170	55.7	9.7	238	Neg.	57.4	9,600	2.74	55.0
	210	70.1	12.4	184	Neg.	60.0	9,240	2.71	55.1
	250	85.0	16.2	139	Neg.	60.0	9,540	3.13	..
	290	100.5	23.7	101	Neg.	65.6	9,420	3.67	54.4

tionship between freeness and drainage time is a function of the temperature during the beating process. Compared at the same freeness, the drainage time is increased as the temperature of the different beater runs is decreased. The two runs made at uniformly varied temperatures fall logically into line with the results of the runs at constant temperatures.

Fiber classification tests were made for all runs. The resulting points were rather scattered and conclusions were difficult to make. There seemed to be, however, somewhat higher intermediate fraction values for the low temperature runs and the fine fraction seemed slightly higher for the runs made at elevated temperatures. The coarse fraction did not show much variation from one temperature to the other.

Strength Properties. Figure 5 indicates that the lowest temperature runs exhibit the lowest bursting strength values with a general improvement with rising temperature. In the range of drainage time for starting greaseproofness the runs made at moderately high temperatures give the best values. Also the tensile strength values (Fig. 6) are found to be lowest at the lowest beating temperature. The highest values are developed by the run at 40°C. with lower strengths for the temperatures both above and below this value. Within the range of high drainage time the breaking lengths for the 30 and 60° runs reach the high values for the 40° run. Stretch values were observed in connection with the testing for tensile strength (Fig. 7). It is obvious that the highest values were developed by the beater runs carried out at 80°C. and the lowest values for the low temperatures, with a somewhat uniform decrease in values as the temperature is lowered. Also the curves for the tear factor (Fig. 8) seem to indicate that the lower values are in general found for the low beating temperatures. There is no trend in the position of the different temperature curves. This could be due to the fact that each observation point is an average of only four tests and the scattering of the points is rather large. Additional tests made on the handsheets but which are not reported here are folding endurance, bulk, and transparency. Concerning the folding endurance, only six tests were made to give an average for each observation point, which is obviously inadequate. Consequently a great scattering of the points occurred which made it impossible to obtain reliable curves. However, there seemed to be an indication that here also the trend was toward lower values for the low temperatures. The bulk values for all the beater runs fell within a narrow range indicating that the influence of temperature was negligible. Neither was the influence of temperature on the transparency pronounced.

Beating at 4% Consistency, Air-Dry Pulp Furnish

The results of these runs are included in Table II and shown in Figs. 9 to 12. For comparison the curves for similar beater runs with wet pulp furnish are reproduced.

Rate of Beating. The curves for specific beating time (Fig. 9) show clearly that the time necessary to reach a certain drainage value is greatly increased for all temperatures when air-dry pulp is used as the furnish. Especially noticeable is the pronounced decrease in beating rate for the run carried out at 15°C. The beating time for this temperature is even longer than for the run at 40°C. At 30°C. the beating time was found to be the shortest. A faint positive blister test was noted for this beater run at a drainage time of 112 seconds. For the corresponding run starting with wet pulp the same degree of greaseproofness was found at a drainage time below 40 seconds. None of the other

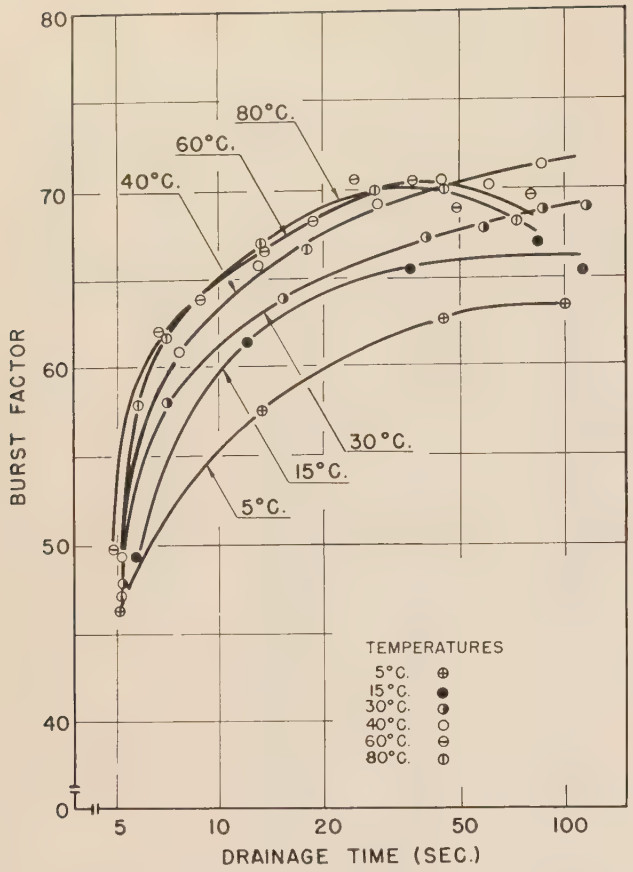

Fig. 5. Burst factor vs. drainage time. 4% consistency. Wet pulp furnish

beater runs gave any positive test at the point where the beating was stopped. In some cases the runs were terminated before a positive blister test could be expected. The trend in the relationship between freeness and drainage time was the same as for the comparison runs starting with wet pulp.

Strength Properties. Figure 10 indicates that the burst factor is considerably lower for the "dry" runs at all temperatures, giving a decrease of approximately 10 to 20%. In general, the maximum factor was developed at the higher temperatures, although the values at 30°C. exhibit an exception, being lower than for the run at 15°C. Also the values for tensile strength (Fig. 11) are definitely lower than for the corresponding "wet" runs (a decrease of about 10%), with the maximum values at 40 and 15° and the minimum values at 30° (shortest beating time). The tear factor, on the other hand, exhibits higher values (an increase of about 5 to 20%), with the maximum values for the low-temperature runs, 15 and 30° (Fig. 12). Also the bulk factor gave higher values over the whole range of drainage time.

Beating at 2.5% Consistency, Wet Pulp Furnish

Rate of Beating. When beating was conducted at 2.5% consistency, it was found (Table III and Fig. 13) that the specific beating time required to reach a certain drainage time was longer for all temperature runs, compared with runs made at 4% consistency. The least difference was found at 40°C. The relationship between freeness and drainage time was essentially the same. So was also the appearance of the point for initial positive blister.

Table III. Beater Runs Conducted at 2.5% Consistency, Wet Furnish

	Beating time, min.	*Specific beating time, min./kg.*	*Drainage time, sec.*	*Blister test*
Run no. 13—	0	0	5.0	Neg.
Beating	30	15.0	13.9	Neg.
temp.,	60	30.3	37.9	V. slight
15°C.	90	45.9	71.6	Alm. def.
	110	56.4	95.5	Def.
	130	67.1	116.3	Def.
Run no. 14—	0	0	5.5	Neg.
Beating	30	15.0	10.7	Neg.
temp.,	60	30.3	29.0	V. slight
40°C.	90	45.9	62.3	Def.
	110	56.4	92.5	Def.
	130	67.1	130.0	Def.
Run no. 15—	0	0	5.1	Neg.
Beating	30	15.0	6.7	Neg.
temp.,	60	30.3	10.2	Neg.
60°C.	90	45.9	19.0	Neg.
	110	56.4	25.1	Neg.
	130	67.1	37.2	V. slight
	150	78.0	52.1	Slight
	190	100.5	90.2	Alm. def.
Run no. 16—	0	0	4.9	Neg.
Beating	30	15.0	5.8	Neg.
temp.,	60	30.3	7.5	Neg.
80°C.	90	45.9	9.1	Neg.
	110	56.4	10.3	Neg.
	130	67.1	13.5	Neg.
	150	78.0	18.9	Neg.
	170	89.1	25.9	Neg.
	210	...	46.5	V. slight

Strength Properties. The change in consistency did not alter the trends in the development of the strength properties to any great extent. However, there were some irregularities in the position of the curves with relation to beating temperature, particularly for tensile strength and stretch. In general, the different curves

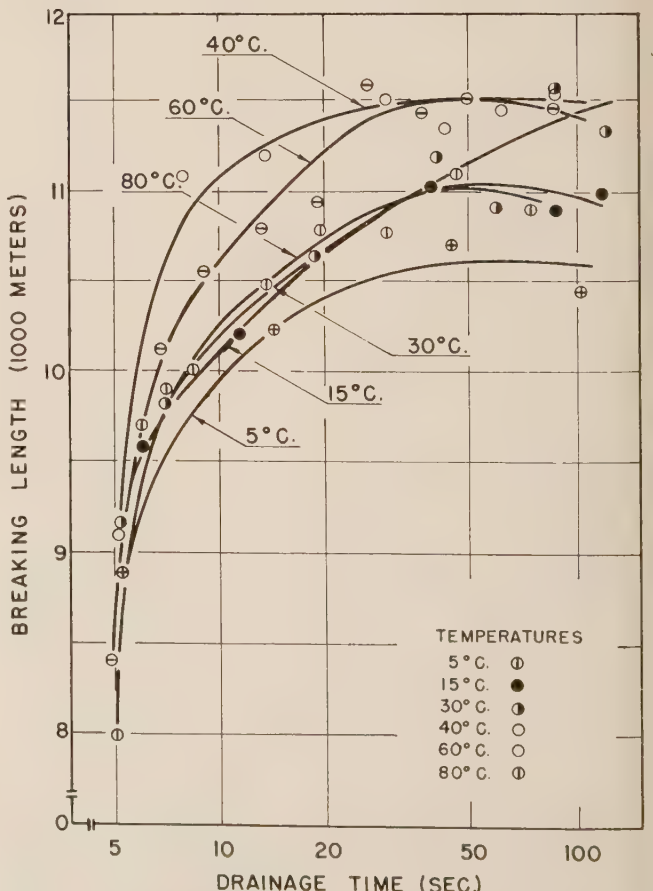

Fig. 6. Breaking length vs. drainage time. 4% consistency. Wet pulp furnish

were grouped somewhat closer together, indicating a smaller influence of temperature on the various strength characteristics.

SUMMARY AND DISCUSSION OF RESULTS

Rate of Beating

The results of the runs made at 4% consistency, wet pulp furnish, verified the findings of previous investigators like Noll (*11*, *12*), Hall (*2*), and others, that high temperature in the beater will slow down the rate of beating as measured by freeness and drainage time. The most rapid beating will occur at the lowest temperature and the rate of beating is decreased as the temperature is increased. The same trend was shown by the runs carried out at 2.5%. These latter runs showed a generally slower rate of beating as compared with the runs made at 4% consistency. This result seems to indicate that a lowering of the consistency in the beater will increase the beating time at all practical beating temperatures. A hypothetical two-stage beating process starting with a high consistency, followed by a later dilution with cold water to a lower consistency in order to keep the temperature down, would therefore probably not show any advantage. The decrease in beating time as a result of cooling the stock would be counteracted by a slower beating action caused by the decrease in consistency.

The beater runs starting with air-dry pulp required a considerably longer beating time compared with similar runs starting with wet pulp. This could be expected, as in the latter case an intimate contact between the water and the pulp had been already established before the beating process began, while for the air-dry pulp this contact had to be initiated in the beater. A very

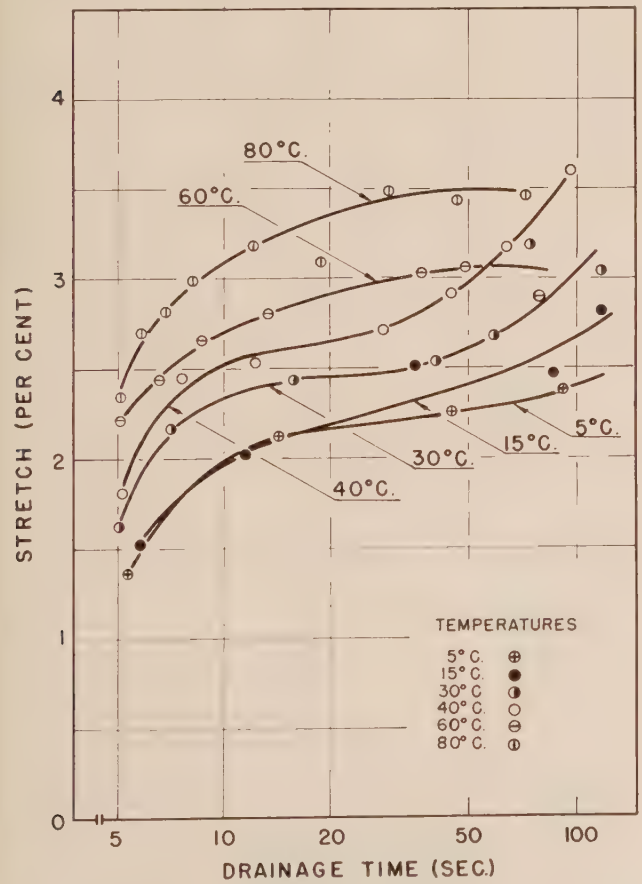

Fig. 7. Stretch vs. drainage time. 4% consistency. Wet pulp furnish

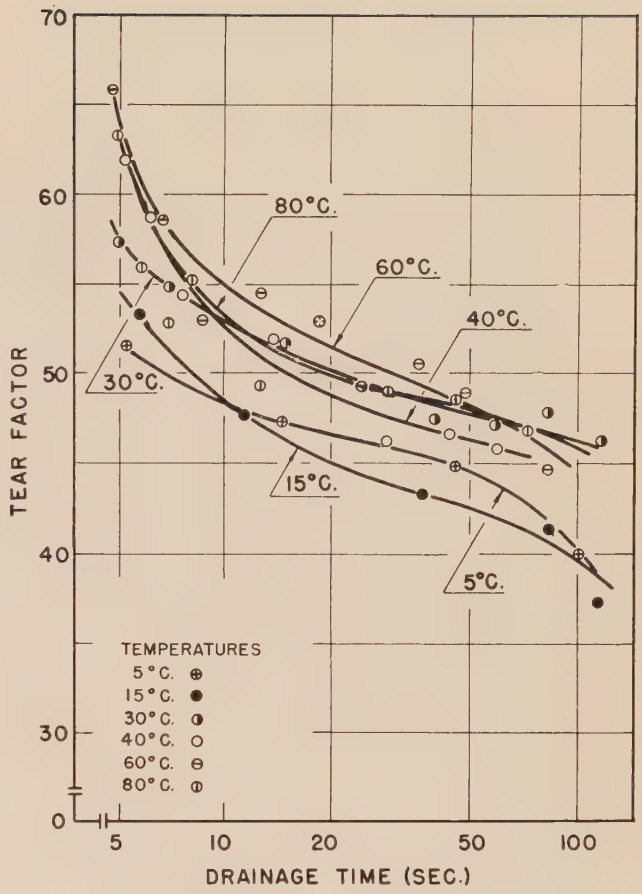

Fig. 8. Tear factor vs. drainage time. 4% consistency. Wet pulp furnish

interesting discovery was the extremely long beating time required by the low-temperature run (15°C.). This run required a beating time nearly as long as for the run made at 80°C. with wet pulp. The fastest beating took place at 30°C. This falls in line with the result of the investigation made by Lewis and Gilbertson (*7*), who, contrary to other investigators, found the lowest beating time at an intermediate temperature (25°C.) and that the time was increased as the temperature was either raised or lowered. It was apparent that in these experiments the rag stock was added to the beater in an air-dry condition. Therefore, it seems logical to assume that the disparity in results may be explained by the difference in moisture condition of the stock furnished to the beater.

The penetration of the suspending liquid into the capillaries of the fibers theoretically may be considered the principal requirement for a swelling of the fibers during the beating of the pulp. To facilitate this penetration, gases (air) must be driven out to make space for the suspending liquid (water), which is forced in because of the surface tension. The removal of air is favored by heat (Strachan (*16*)) and this action is therefore intensified by an elevated temperature. The surface tension of water is decreased in an almost linear way with rising temperature, which means that the possible depth of penetration into the capillaries is diminished when high temperatures are employed. In this case that would imply that the beating time for the beater runs furnished with wet pulp would be influenced mainly by the change in surface tension with temperature as only a small amount of air remains to

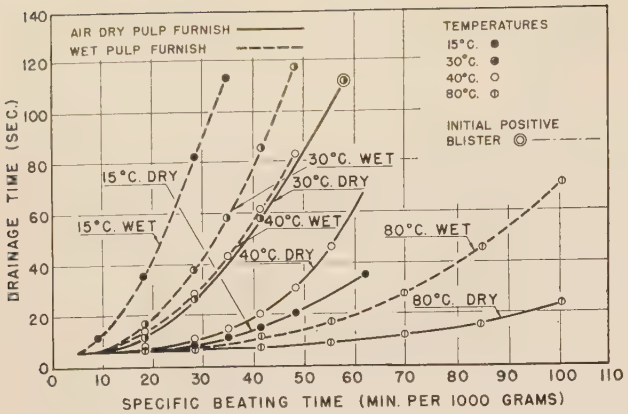

Fig. 9. Drainage time vs. specific beating time. 4% consistency. Air-dry pulp furnish

be removed. In other words, the fastest beating could be expected at the lowest temperature (highest surface tension). On the other hand, for beater runs made with air-dry pulp, a greater quantity of air must be driven out to permit penetration of the water. This means that the beating time will be partly influenced by the ease with which air is removed and partly by the variation in surface tension with temperature. For the low-temperature runs the removal of air is slow. This retards the penetration of water even if the surface tension is high. During runs at high temperatures the air is easily removed, but the possible depth of water penetration into the capillaries is less because of lower surface tension. Therefore, it seems logical that some intermediate constant beating temperature will give the shortest beating time when the beater is furnished with air-dry stock. This gives a possible explanation for the different results achieved in the various investigations made on beating temperature versus beating time.

Another interesting fact, developed by the experiments on the rate of beating, is the marked influence of the beating temperature on the relationship between freeness and drainage time. It was shown that, independent of consistency during the beating or moisture content of the pulp furnished, the same freeness corresponds to a higher drainage time as the beating temperature is lowered. This result may be taken as an indication that more cutting of the fibers takes place as the beating temperature is increased and that a squeezing of the fibers predominates when the beating is carried out at low temperatures. A positive blister test was reached sooner and resulted at a higher freeness or lower drainage time when the beating temperature was kept low. This result also indicates more swelling at lower temperatures.

If the drainage time on the sheet mold is taken as a criterion of the behavior of the stock on the paper machine wire, it is obvious that stock beaten down to a certain freeness will behave differently depending upon the temperature that prevailed during the beating process. At the same freeness, stock beaten at higher temperatures will drain faster than stock resulting from low-temperature beating. Further investigations along this line would seem desirable. In the same connection it would also be interesting to compare the greaseproofness of handsheets made from pulp beaten at various temperatures with similar qualities of handsheets made from the same beaten pulp after additional heating, corresponding to a heating of the stock before it goes onto the paper machine wire.

Strength Properties

With some modifications it can be said that the optimum strength properties were generally found to be developed by an elevated beating temperature. An extreme cooling of the stock gave the lowest values. The burst factor improved rather uniformly with rise in temperature showing the highest values in the upper temperature range. The curves for tensile strength did not show quite the same regularity. For the principal runs made at 4% consistency the highest values resulted from beating at 40°C. while the runs made at 2.5% consistency gave the highest values at a beating temperature of 15°C. The highest stretch values generally resulted from the highest temperature runs. The tear factor appeared to be lowest for the low-temperature runs when wet pulp was used as the furnish. When air-dry pulp was employed the lowest temperature (15°C.) showed the highest value. Without exception, the runs made with an air-dry pulp furnish showed considerably lower burst and tensile strength values and somewhat higher tear and bulk values at all temperatures, compared with similar "wet" runs. Apparently, the beating action varied with the different temperatures depending upon the stock consistency and the moisture content of the incoming stock, thereby accounting for some of the irregularities in the curves. The low-strength characteristics developed by the runs which were started with air-dry pulp, indicate that these fibers were in a state where they were less able to withstand the pressure of the beater roll.

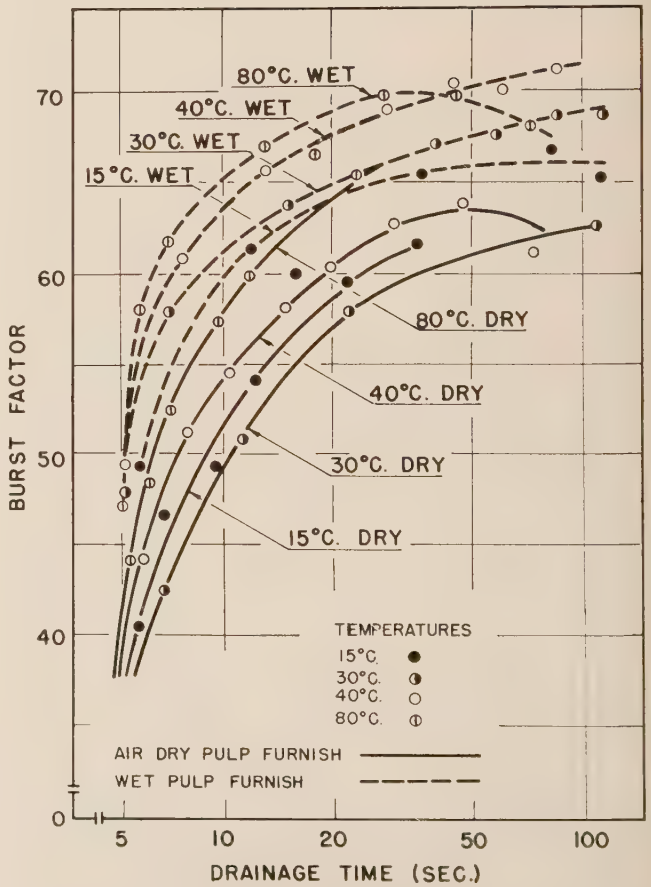

Fig. 10. Burst factor vs. drainage time. 4% consistency. Air-dry pulp furnish

Previous work dealing with beating and temperature indicates that the strength properties remain constant (*1*, *2*) or are generally lowered (*7*, *11*) when the temperature of beating is increased. This is contrary to what has been found in this investigation, namely that the optimum strength values are developed at moderately high temperatures. It should be borne in mind that no attempt has been made in the present work to prevent any cutting action on the fibers. In the most important of the previous investigations in this field, equipment and conditions were employed which would tend to keep the cutting action down to a minimum. This equipment included a Clark kollergang (*1*, *11*), a Lampén mill (*2*), and a Noble and Wood cycle beater with a comparatively large clearance between roll and bedplate (*7*). Because of this difference the results presented in this paper do not necessarily disagree basically with results reported in other investigations. On the contrary, the discrepancy in results of the various investigations may be interpreted as presenting conclusive evidence that the variations in strength characteristics caused by a change in beating temperature are largely dependent upon the kind and condition of the beating equipment used and the conditions maintained during the beating process. In other words, it is doubtful if it is possible to make any general accurate statements about the influence of a variation in beating temperature on the strength properties of the resulting paper.

INFLUENCE OF SURFACE TENSION ON BEATING TIME

Noll (*11*) made the hypothesis that a decrease in the surface tension of water with increasing temperature was the reason for the slowing down of the beating action. Based on this hypothesis, it would seem interesting to investigate the addition to the beater of compounds having the primary effect of increasing the surface tension of the water suspension. In this way the effect of an increase in temperature would be expected to be diminished. An addition of certain synthetic resins (Shofield and Ainsworth (*13*)) and some of the cellulose ethers has proved successful in decreasing beating time and improving certain qualities of the finished paper. These compounds do not give any increase in the surface tension of water. On the contrary, most of them have quite a large adverse effect. Their favorable action, therefore, cannot be explained by Noll's hypothesis. Also, Harrison (*3*) found that an addition of wetting agents to the beater slowed down the beating action.

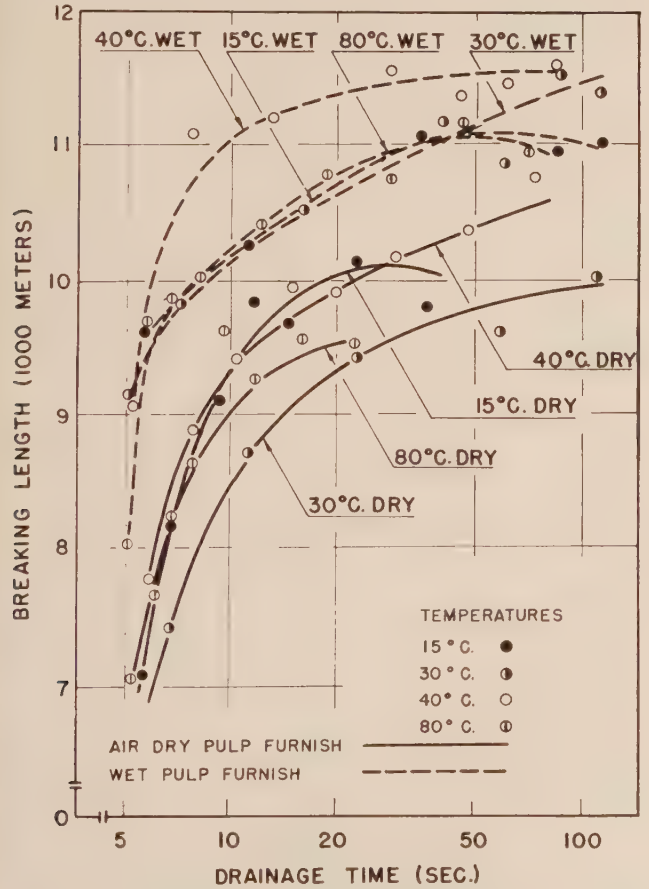

Fig. 11. Breaking length vs. drainage time. 4% consistency. Air-dry pulp furnish

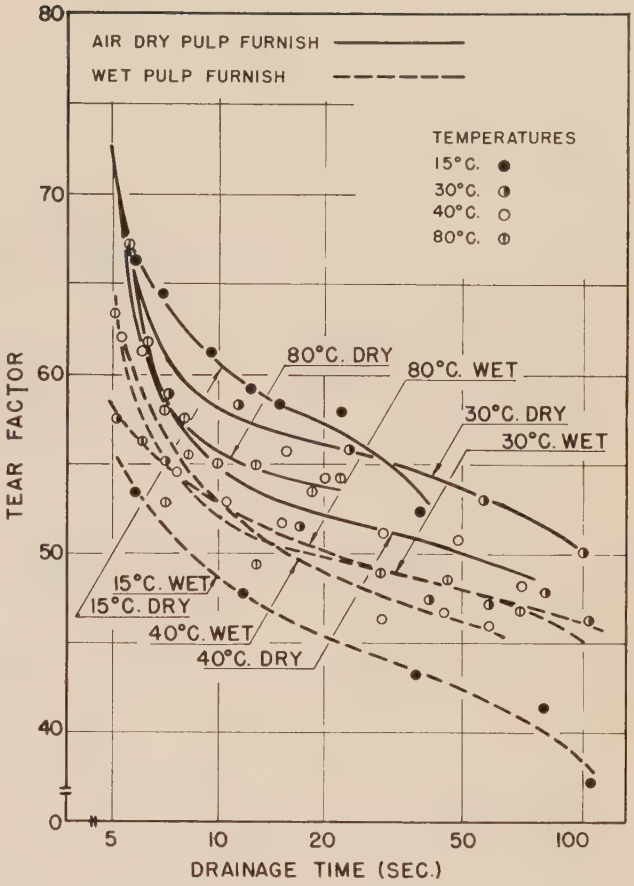

Fig. 12. Tear factor vs. drainage time. 4% consistency. Air-dry pulp furnish

Certain compounds will increase the surface tension of water, some of these being inorganic salts like sodium chloride, sodium carbonate, sodium sulphate, and others, together with dilute solutions of certain common inorganic acids and bases. The effect of these compounds on beating time and also on the strength properties has been investigated by Noll (*11*), Strachan (*16*), Mansfield and Stephenson (*8*), Nakano (*10*), and others. The results of these investigations show, as a general rule, that the addition of these chemicals will accelerate the beating process. It seems, however, that this effect in some cases is only apparent and can be attributed to a deterioration of the cellulose by the added chemicals. In many cases the paper turned out to be very weak. Salts like sodium sulphate and sodium carbonate, which are considered fairly inactive toward cellulose, cause an increase in the surface ten-

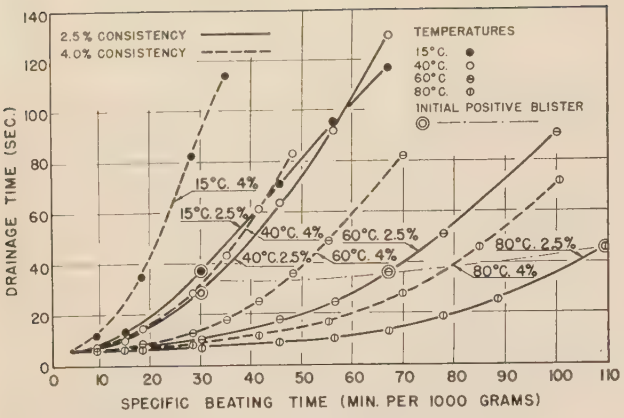

Fig. 13. Drainage time vs. specific beating time. 2.5% consistency. Wet pulp furnish

sion of aqueous solutions compared with air of about 2.8 dynes per cm., when a 1 *N* solution is used. This is a small effect compared with the influence on surface tension of temperature, but it would be interesting to investigate the beater addition of various amounts of these compounds. However, the advantages of such additions would be rather doubtful in actual mill operation.

Stimulated by the works of Noll (*11*) and also of Kress and Bialkowsky (*6*), some experiments on surface tension in connection with beating were carried out during some of the constant temperature runs. The objective was primarily to determine if the surface tension of the beating liquid changed during the beating process and to what extent such a change would be influenced by the beating temperature.

An apparatus was set up based on the capillary rise method of determining surface tension. It consisted of a graded capillary tube attached to a 180° bent glass tube of larger inner diameter. The apparatus was immersed in a water bath for temperature control. Measurement of the surface tension of the beating liquid was carried out in connection with the constant temperature runs at 15, 30, and 80°C. wet pulp furnish, 4% consistency. A test sample from each stage of the beating was filtered through filter paper on a suction flask and the filtrate collected. A second filtration was made before testing. The liquid was sucked into the apparatus which previously had been cleaned with soap and hot cleaning solution. After rinsing with the testing liquid, the readings were taken on a fresh sample. The results of the measurements are shown in Table IV where the values for distilled water are also listed. For each temperature investigated, the surface tension is the same for all samples, or at best, only slightly less than that of distilled water at the same temperature. The variations in the values are within the range of experimental error. It may therefore be concluded that there is no measurable change in the surface tension of the beating liquid as the beating proceeds. Apparently this is the case at all practical beating temperatures. The data presented in Fig. 3 show that there is a progressive increase in beating time between equal temperature intervals when the temperature is raised, giving a very long beating time at the highest temperatures. If the surface tension hypothesis is accepted, it would be logical to expect that the surface tension of the beating liquid would decrease more than that of distilled water with rising temperature, which is almost linear. The investigation indicated that this was not the case and factors other than surface tension must therefore be responsible for this phenomenon.

CONCLUSIONS

1. The rate of beating of a strong sulphite pulp is most rapid at low beating temperatures when the pulp is furnished in a wet condition.
2. Beater runs made with an air-dry pulp furnish show the highest rate of beating at an intermediate temperature. Beating temperatures below or above this level will cause a gradual decrease in beating rate.
3. A decrease in consistency of the stock in the beater (from 4 to 2.5%) slows down the rate of beating at all temperatures.
4. The relationship between freeness and drainage time of the stock is influenced by the temperature of beating in such a way that an increase in temperature decreases the drainage time corresponding to a given freeness.
5. Initial greaseproofness occurs at a higher freeness, or a lower drainage time, when the temperature of beating is lowered. The use of an air-dry pulp furnish will greatly delay the appearance of the greaseproof point at all beating temperatures.
6. A moderately high beating temperature appeared in this investigation to give the best average strength properties to the paper.
7. Pulp furnished to the beater in an air-dry stage gives at all temperatures lower burst and tensile strength values and higher tear and bulk values than the same pulp furnished to the beater in a wet condition.
8. The surface tension of the beating liquid does not change to any noticeable extent during a beating process at constant temperature. This is true for all beating temperatures.
9. This investigation has demonstrated that a cooling of the stock during the beating process is of considerable economic value as far as beating time and the resulting power consumption are concerned. The most favorable temperature appears to depend upon the moisture content of the original pulp furnish.
10. This investigation has proved that an accurate

Table IV. Surface Tension Measurements on Distilled Water and Liquid from Beater Runs Made at 15, 30, and 80°C.

Beating temp., °C.	*Beating time, min.*	*Surface tension, dynes/cm.*		
		Beating liquid	*Distilled water*	
			Measured	*I.C. tables*
15	0	73.5	73.5	73.49
	30	73.0		
	60	73.0		
	90	72.8		
	110	72.8		
	130	72.8		
	150	72.9		
30	0	70.6	71.2	71.18
	30	70.7		
	60	71.2		
	90	70.6		
	110	71.5		
80	0	62.8	64.5	62.61
	30	64.3		
	90	64.0		
	130	64.0		
	170	64.0		
	210	64.4		
	250	64.1		
	290	64.5		

general statement relative to the influence of beating temperature on the strength properties of paper cannot be made.

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Factors Influencing the Retention and Efficiency of Wet-Strength Resins

C. S. MAXWELL, W. F. REYNOLDS, and R. R. HOUSE

Three typical wet strength resins, (1) melamine formaldehyde acid colloid (cationic), (2) anionic urea formaldehyde resin, and (3) cationic urea formaldehyde resin are compared on a laboratory scale under a wide variety of circumstances. Factors that were found to affect the efficiency of one or more of these resins include: (1) concentration of anions and cations in the stock, (2) character of the pulps themselves, (3) degree of refining of the pulp, (4) time of contact between resin and fiber, (5) stock temperature, (6) degree of cure, and (7) cooking and bleaching residues. A number of curves and tables, illustrating the effects of the variables studied, are given.

The majority of thermosetting resins used for the wet-strength treatment of papers by slush stock addition can be separated into three distinct types*: (1) melamine formaldehyde (MF) acid colloid (cationic), (2) anionic urea formaldehyde (UF), and (3) cationic urea formaldehyde. There are undoubtedly some wet-strength resins on the market that do not fall into any of the above classifications, but these are in the minority and are not considered in the following discussion.

In the utilization of wet-strength resins, it has been found that certain conditions are conducive to high efficiency, while certain other conditions are detrimental. Furthermore, conditions that are ideal for one type of resin may not be for another. In determining the effectiveness of a beater wet-strength resin, it is a common fallacy to depend too much on the amount of resin retained. Under certain conditions it is quite possible to obtain excellent wet strength at very low resin retention and, conversely, to develop very little wet strength with high resin retention. It is of interest, however, to note the relative retention of the three types of resin under fairly normal papermaking conditions.

There are several reasons for failure to find all of the added resin in the sheet: (1) all of the resin in a given sample may not be substantive to cellulose, and therefore would not be capable of being retained; (2) the fine pulp fractions have a very large area relative to their mass and tend to adsorb resin in direct ratio to this area. Fairly large amounts of these fines—with adsorbed resin—may pass through the forming wire into the white water system, (3) the adsorption of the resin may be so slow, and the point of resin addition to the stock so late, that there is insufficient time for the resin to be fully adsorbed before the stock reaches the forming wire. With respect to speed of pickup, the melamine acid colloid and the cationic-type urea resin tend to be picked up faster than the anionic urea resin. However, the actual rates of pickup will vary with stock consistency and other papermaking variables.

	Resin retained—from 3% added	
	Maximum observed	*Usual range of retention*
MF-acid colloid	3.0	2.1–2.5
Anionic UF[a]	1.6	1.1–1.5
Cationic UF	2.2	1.6–2.0

[a] In unbleached kraft.

Some of the factors that affect the efficiency of the various wet-strength resins are discussed separately in the following sections.

The data presented are based on controlled laboratory experiments where the utmost care was taken to separate the variables being studied. It is almost impossible to secure such separation under usual mill conditions. Unless otherwise noted, the following procedure was carried out in obtaining all test data. Unbleached northern kraft pulp was beaten to a freeness (Canadian) of about 500 ml. Batches of the pulp, at 0.6% consistency, were treated with 3% alum and 3% of the wet-strength resin and processed into handsheets (of about

* The three resins actually used were PAREZ Resin 607 (MF), PAREZ Resin 610 (UF-anionic), and PAREZ Resin 609 (UF-cationic) produced and sold by American Cyanamid Co. It is not necessarily implied that all other resins that can be classified in these three groups would behave exactly as these three specific resins.

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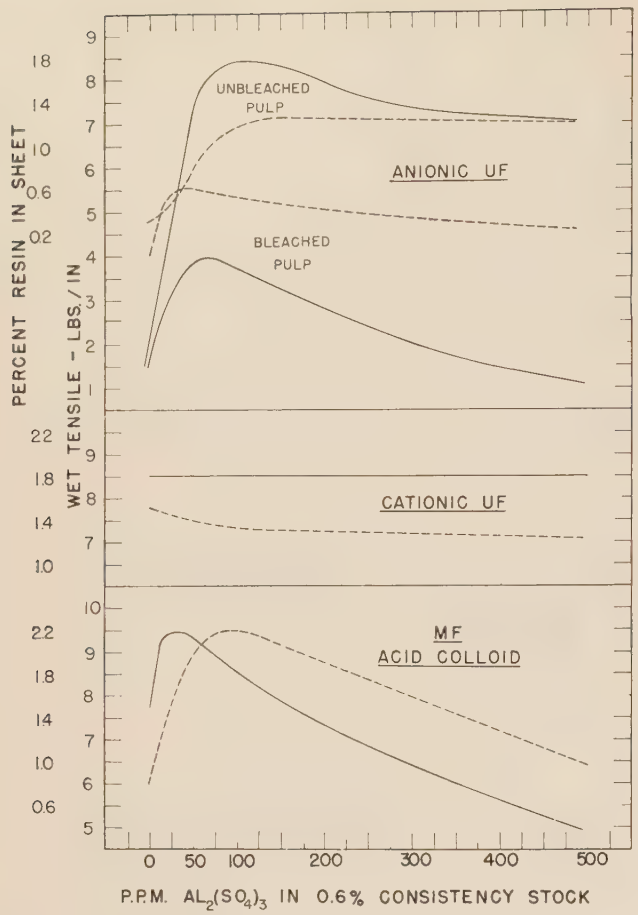

Fig. 1. Effect of alum on retention and efficiency of wet strength resins

—— Wet tensile. ----- Resin retention.

50 pounds 25 × 40—500 basis weight) on a Nash handsheet machine. The dilution water, as well as the stock itself, was adjusted to pH 4.5. The formed sheets were pressed by one pass through a rotary press loaded to 120 pounds per linear inch. Each sheet was then dried immediately in contact with one damp blotter for 2 minutes on a drum drier at 240°F. The sheets were allowed to condition at least 24 hours at 73°F. and 50% R. H. before testing. The wet tensile strength was used throughout as a yardstick of resin efficiency but it should be remembered that the "resin bonding" action of these resins is also reflected in improved dry properties such as tensile, burst, folding endurance, and wax pick.

SOME FACTORS INFLUENCING WET-STRENGTH RESIN EFFICIENCY

Salts

The effect of salts on the melamine acid colloid has been covered fairly completely in a previous paper (*1*). In determining the effect of salts on the urea resins it was at first assumed that they would produce the same effects that they did on the melamine resin. However, this assumption had to be discarded quickly. With the urea resins, as with the melamine colloid, it was found that ions rather than complete salts had to be considered, that the charge of the ion [cationic (+) or anionic (−)] was important and that the valence or total charge of the ion was important. Figure 1 shows the general effect of cations and anions on the retention and efficiency of the three types of wet-strength resins under discussion.

It should be noted that the ions added (Al^{+++} and SO_4^{--}) are both polyvalent, and one or both can produce significant effects on the usefulness of some of the resins.

From the foregoing figure, and other data not presented, the following relationships are evident.

Melamine Formaldehyde Acid Colloid (Cationic). Its effectiveness is influenced by anions, not by cations. The potency of the anion increases with valency (mono, di, tri) roughly in the magnitude of 1:10:30.

Optimum conditions for wet strength do not exactly coincide with optimum conditions for retention. Optimum wet strength is reached at about 25 p.p.m. of SO_4^{--}(250 p.p.m. Cl^- or 8 p.p.m. of $Fe(CN)_6^{---}$) while optimum retention is obtained at about three times this concentration. Still higher anion concentration at point of resin addition tends to reduce both the wet strength and resin retention.

Anionic Urea Formaldehyde Resin. The effects of ions on this resin are quite involved, as both cations and anions have a role. A minimum concentration of cation is essential for resin pickup and in commercial practice this is usually obtained from the Al^{+++} in papermakers' alum. Cation in excess of this optimum does not appear to affect the resin retention, but may have adverse effects on the wet strength.

Anions (e.g., sulphates) seriously reduce the efficiency of this resin in bleached pulps but, fortunately, have very little effect in unbleached kraft where this resin is widely used.

Cationic Urea Formaldehyde Resin. The peculiar feature of the cationic urea resin is that, although the resin retention is reduced by cations (such as Al^{+++}),

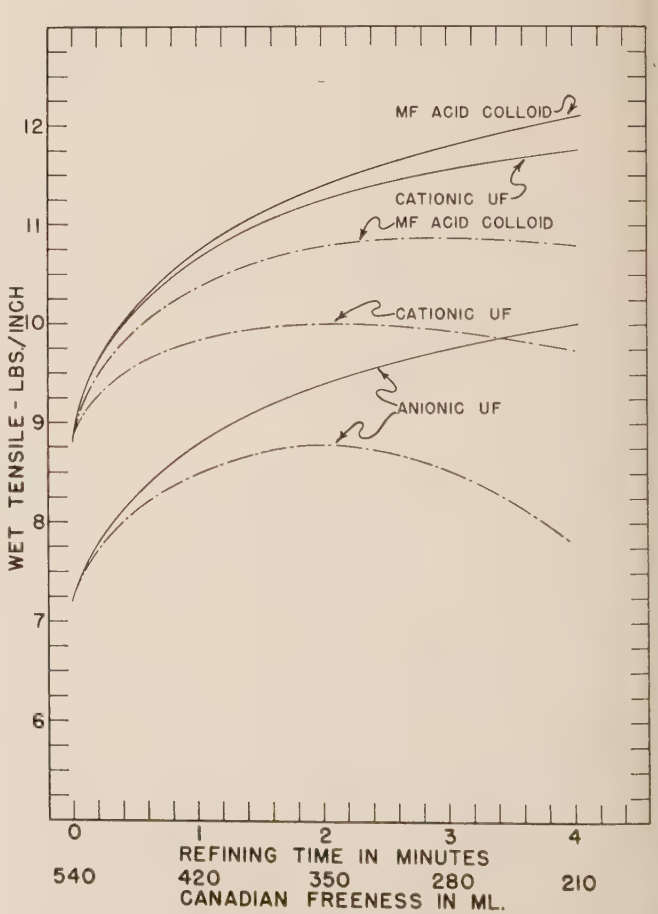

Fig. 2. Effect of refining on wet tensile strength

—— Resin added after refining. ----- Resin added before refining.

Table I. Effect of Types of Pulp on Efficiency of Wet-Strength Resins

	Tensile strength—lb./in.															
	Rag		Alpha		Bleached kraft		Unbleached kraft		Unbleached groundwood		Unbleached semichemical		Bleached sulphite		Unbleached sulphite	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
No resin	22.5	1.2	16.6	<0.4	22.0	1.1	21.0	0.8	11.2	0.6	28.6	1.6	13.1	<0.4	23.6	0.8
MF-acid colloid	29.0	12.0	25.7	8.8	29.2	9.0	28.8	8.2	14.8	5.4	31.6	5.2	22.6	6.6	30.1	9.4
Anionic UF	23.2	3.0	18.2	2.1	27.0	3.4	33.0	7.0	13.0	1.6	26.8	2.2	16.7	1.9	24.0	1.7
Cationic UF	27.0	6.1	23.8	6.6	29.4	7.0	28.8	7.4	13.8	4.2	28.6	4.2	22.3	6.0	29.7	9.2

	Other test data															
	% Resin in sheet	MIT fold	% Resin in shset	MIT fold	% Resin in sheet	MIT fold	% Resin in sheet	MIT fold	% Resin in sheet	MIT old	% Resin in sheet	MIT fold	% Resin in sheet	MIT fold	% Resin in sheet	MIT fold
No resin	...	408	...	36	...	326	...	435	...	<2	...	198	...	...	...	...
MF-acid colloid	2.3	2575	2.2	955	2.2	833	2.3	1657	2.4	<2	2.0	394	1.6	...	1.8	...
Anionic UF	0.4	587	0.3	71	0.5	373	1.3	1373	0.8	<2	0.6	172	0.2	...	0.3	...
Cationic UF	1.3	1253	1.5	616	1.7	996	2.0	1399	2.2	<2	1.6	432	1.3	...	1.6	...

Note: 3% resin added in all cases.

the wet strength remains essentially unchanged. This apparent anomaly is presumed due to the effective buffering action of the salt ($Al_2(SO_4)_3$) used which permits better cure of the resin that is retained. Anions have no apparent effect on the wet strength or retention.

Pulps

It was quite reasonable to expect that the relative effectiveness of these resins would be different in various types of pulps. This expectation was correct in the case of the anionic UF resin, and it has become an accepted fact that this resin is almost a specific for unbleached kraft, and shows much lower efficiency in most other types of pulps, whether bleached or unbleached. However, the other two types of resin (melamine acid colloid and cationic urea resin) are not as specific. An idea of the relative efficiencies of the three types of resin in various pulps is shown in Table I.

It can readily be seen from this table that the three resins are roughly equivalent only in unbleached kraft. With most of the pulps the melamine resin treatment gave about 25 to 35% higher wet strength than the cationic urea treatment but with the highly purified rag pulp the melamine resin was almost 100% more effective. It is therefore evident that the character of the fiber furnish should be considered in deciding which type of resin to use. With complex furnishes this can probably be decided only by actual trials. From the discussion of other variables covered in the following sections, it will be apparent that the actual values obtained with any particular combination of resin and pulp can be drastically changed by conditions.

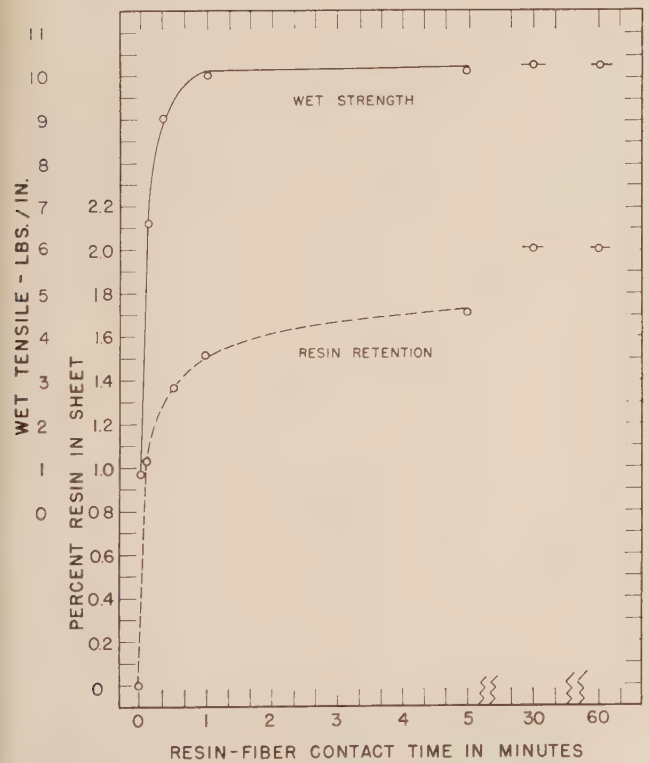

Fig. 3. Effect of contact time between melamine acid colloid and fibers

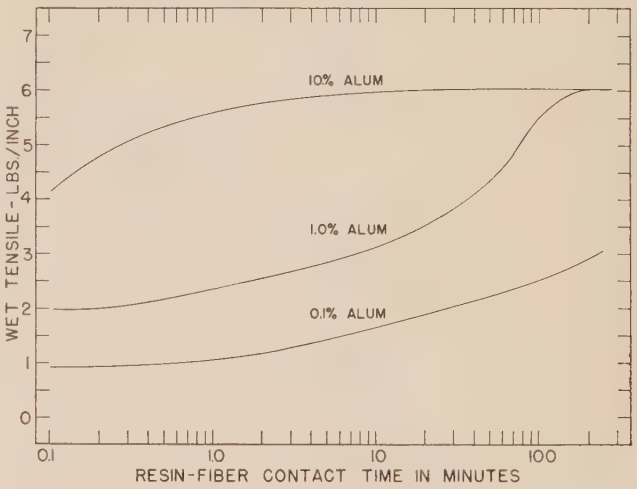

Fig. 4. Effect of alum on anionic UF resin

Degree of Refining

The amount of resin, regardless of its type, that can be picked up by a given fiber weight appears to be tied in directly with the state of subdivision of the fiber or, probably more correctly, with its surface area. Thus, an unbeaten pulp will tend to pick up less resin and will have lower dry and wet tensile strength than the same pulp beaten to a greater extent.

It makes an appreciable difference in the final wet-strength values, whether the resin is added *before* or *after* the refining action. If the resin is allowed to adsorb before refining, it apparently loses its power to rearrange and protect the newly exposed fiber surfaces.

A comparison of the effectiveness of the three resins at various degrees of refining is shown in Fig. 2. The effect of adding these resins before and after refining is also shown in this figure.

Contact Time and Pulp Consistency

The three resins apparently follow the general rules of adsorption in that the resin pickup is dependent on time of contact with the pulp, concentration of the adsorbent

Table II. Effect of Bleaching Residues on Wet Strength

Ratio of unwashed to washed pulps		Melamine acid colloid		Anionic UF resin		Cationic UF resin	
Unwashed	Washed	% Resin in sheet	Wet tensile, lb./in.	% Resin in sheet	Wet tensile, lb./in.	% Resin in sheet	Wet tensile, lb./in.
0	100	2.2	8.0	0.8	3.0	1.5	8.0
5	95	2.3	7.6	...	...	1.7	7.0
10	90	2.2	7.4	...	...	...	...
25	75	1.9	7.2	...	...	1.0	4.8
50	50	1.2	5.6	...	...	0.5	3.0
100	0	0.4	2.4	0.2	1.2	0.2	1.4

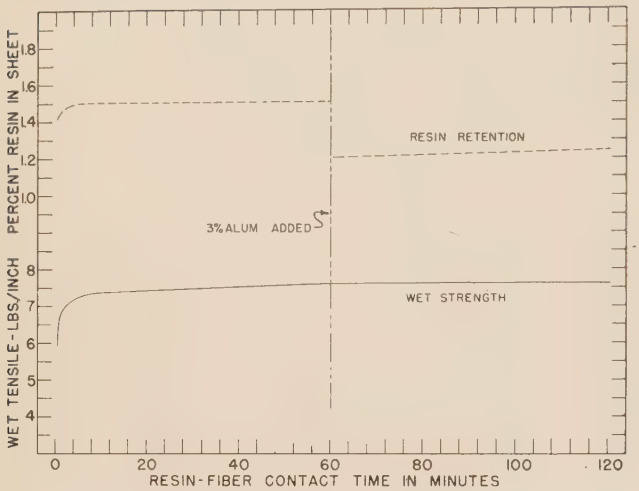
WET TENSILE - LBS./INCH PERCENT RESIN IN SHEET
RESIN RETENTION
3% ALUM ADDED
WET STRENGTH
RESIN-FIBER CONTACT TIME IN MINUTES

Fig. 5. Effect of alum on cationic UF resin

(pulp consistency), and concentration of the resin itself. Besides these factors which affect the resins more or less similarly, there are some factors such as salts to which the resins react differently. The following curves illustrate some of these points. Figure 3 gives the typical retention curve of melamine acid colloid with resulting wet strength. Figure 4 shows the effect of alum on the rate of anionic urea resin adsorption (as measured by wet tensile strength), and Fig. 5 shows the peculiar drop in cationic urea resin retention (but not wet strength) caused by aluminum ion.

A study of the effect of stock consistency has resulted in the conclusion that this factor in itself ordinarily has little bearing on the retention and wet strength imparted by any of the three types of resins, provided that there is sufficient contact between fiber and resin for equilibrium to be reached. There have been some instances where the consistency has *apparently* made big differences in the results but which were finally attributed to other factors such as salt concentration, or time of contact.

Stock Temperature

Either by design or due to circumstances, paper is made from stock varying in temperature from near freezing to hot enough to scald. Wet-strength resins have also been used over this range of temperatures, so the question of their effectiveness at various temperatures is pertinent.

For a laboratory study, unbleached kraft was chosen as all the resins are fairly efficient in this grade. The pulp was beaten to a 300 ml. Canadian freeness which is in the range where higher stock temperatures are often used, and divided into portions for handsheet preparation. In all cases, the stock (at 0.6% consistency) was brought to the desired temperature with ice, steam, or hotplate *before* addition of the resin and the diluting water for the handsheet mold was adjusted to this same temperature. The three types of resin (3% on fiber) were evaluated in stocks at 35, 70, 120, and 160°F.

In the range of temperatures from 35 to 120°F. none of the three resins showed any significant change in effectiveness. However, at 160°F. all resins were less effective—but to different degrees. The melamine resin was about 30% less, the anionic urea resin about 70%, and the cationic urea resin about 40% less. From the appearance of the handsheets, there is the probability that some—but by no means all—of the observed loss of strength was due to poorer sheet formation. Under mill conditions the formation should be easier to control.

It was also interesting to note that the retention of the urea resins dropped rather seriously at the 160°F. temperature, while that of the melamine did not. While a decreased level of adsorption might be expected from the high temperature, it is also possible that the loss of retention and much of the loss of wet strength may be due to resin hydrolysis in the hot stock. (See Fig. 8 for relative rates of hydrolysis.)

Cooking and Bleaching Residues

Most paper mills operate with pulp that has been washed relatively free from cooking liquor. However, in some instances adverse conditions compel the utilization of poorly washed pulp. Similarly, bleaching residues are usually removed before the pulps reach the paper mills, but conditions can exist where residual bleach and products of bleaching are left in the pulp.

The possible effects of these cooking and bleaching residues have not been thoroughly investigated, but enough evidence has been accumulated to indicate that they have been responsible for some of the poor results obtained during the application of wet-strength resins.

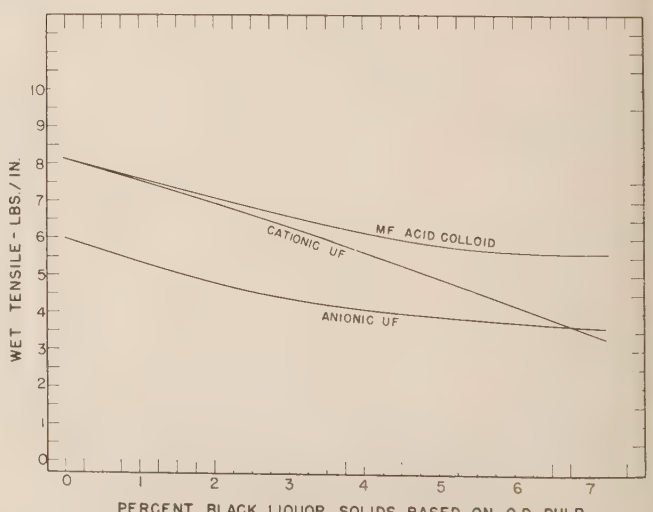

Fig. 6. Effect of black liquor on wet strength

Table III. Effect of Chlorine (Free or Available)

Chlorine in stock (p.p.m. available) Added	Found (at point of resin addition)	Melamine acid colloid: % Resin in sheet	Melamine acid colloid: Tensile, lb./in. Dry	Melamine acid colloid: Tensile, lb./in. Wet	Anionic UF resin: % Resin in sheet	Anionic UF resin: Tensile, lb./in. Dry	Anionic UF resin: Tensile, lb./in. Wet	Cationic UF resin: % Resin in sheet	Cationic UF resin: Tensile, lb./in. Dry	Cationic UF resin: Tensile, lb./in. Wet
...	...	2.2	27.8	8.0	0.8	24.2	2.4	1.5	25.8	5.0
9	1.4	2.0	28.8	7.6	...	...	...	...	...	...
180	120	2.1	24.6	4.4	1.0	24.8	2.0	1.3	23.2	3.6

The effect of kraft cooking residue is illustrated in Fig. 6. For these curves, stock batches (unbleached southern kraft) were contaminated with various amounts of black liquor from southern kraft pulp, before treatment with wet-strength resin. It is obvious that the black liquor affects the wet-strength results and can be particularly serious with the cationic UF resin. It has not been ascertained how much black liquor is usually present in kraft stock ready for the paper mill, but it is probable that slush pulps would tend to have more than dried pulps. The resin retention figures are not shown in Fig. 6, but they too drop off with increasing amounts of black liquor.

The effect of bleaching residue (chlorinated and oxidized lignin, etc.) was specifically determined on a sulphite pulp rather than a kraft because the numerous stages that are required in kraft bleaching make it less likely that high amounts of residue will be left in a fully bleached pulp.

The sulphite pulp was carefully bleached in the laboratory with a single-stage hypochlorite bleach to a brightness of 70, at which point there was no residual hypochlorite. Half of the bleached pulp was drained and thoroughly washed. The other half was left unwashed.

Handsheets, made from these two pulps and from mixtures of the two, using both melamine and urea resins, were evaluated for wet strength. The results are as shown in Table II.

Again, the effects of chlorine on the efficiency of the several resins were determined under laboratory conditions. These data are presented in Table III. It is evident that the bleaching agent itself, as well as the bleaching residues, interferes with the proper functioning of all three types of resins. The reason why chlorine interferes is not at all clear but it is believed that the cooking and bleaching residues form fine insoluble particles under papermaking conditions, which in turn adsorb some of the resin. Many of these fine particles, with accompanying resin, presumably pass through the wire into the white water.

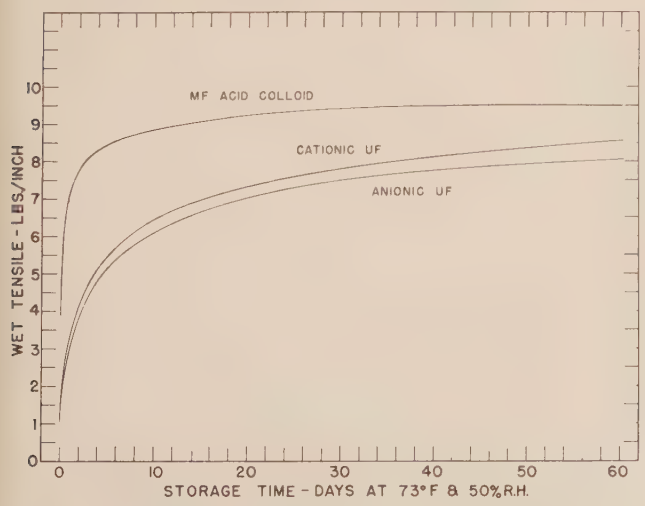

Fig. 7. Relative rates of cure at room temperature

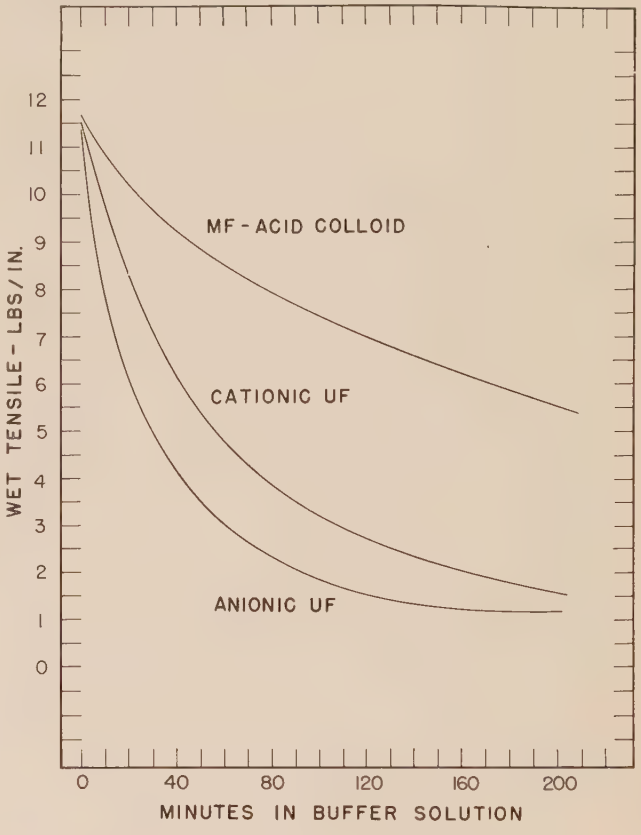

Fig. 8. Loss of wet strength on immersion

Curing Rates and Permanence of Resulting Wet Strength

During early attempts to utilize tub-applied melamine formaldehyde resins to impart wet strength, it was noted that these resins were more difficult to cure then urea resins. However, after the development of the melamine acid colloid as a slush stock additive, it became evident that, at any given pH, the acid colloid resin cured not only faster than the nonacid-treated melamine resin, but even appreciably faster than the urea resins. The wet strength of a melamine acid colloid treated sheet is developed fairly rapidly simply by air-drying at room temperature and it has been found that even by rapid vacuum drying, wet strength develops.

The relative rates of cure of melamine acid colloid resin and urea resins are shown in the following curves (Fig. 7). The handsheets tested in obtaining these data were not heated at all, but were allowed to air-dry. Any heat imparted to the paper as in the usual drying procedure, would, of course, accelerate the development of wet strength in all cases.

Paradoxically, the same general conditions that are

conducive to the rapid cure of melamine and urea resins, with the resulting development of wet strength, are also conducive to the loss of this same wet strength. These conditions are low pH, and high temperature with high moisture. The relative resistance of urea and melamine resin treated papers to loss of wet strength during immersion in water can be readily followed by using the method developed by Britt (*3*) where the paper samples to be tested are suspended in a buffered aqueous medium at a controlled temperature, and tested for tensile strength at intervals. Results of such a test are shown in Fig. 8.

The exact correlation between immersion and atmospheric exposure tests has not yet been determined because of the many complexities involved in controlling the pH, total acidity, temperature, and moisture, and also the possible action of fungi and other microorganisms.

Conditions of efficient broke recovery are similar for both urea and melamine resin treated papers. High temperature and low pH conditions shorten the time required. Because of the greater resistance of melamine resins to hydrolysis, melamine resin treated broke will require a longer time for complete defibering than urea treated broke under any particular temperature and pH environment.

One final word of caution is in order for users of wet-strength resins. Each resin by itself has been remarkably free of troublesome effects on the paper machines. However, some of these resins are anionic, others cationic so the mixing of any two oppositely charged resins either before or after addition to the stock may result in the formation of an insoluble sticky precipitate capable of fouling wire and felts. Before concurrent or consecutive addition of two different resins, the compatability of the two resins should be determined.

CONCLUSION

From the foregoing it is evident that no one type of wet-strength resin is best under all papermaking conditions. In selecting a wet-strength resin for a particular commercial application, the salt content of the stock, the type or types of pulps involved, the severity and location of refining treatment, and the other factors discussed above, should be considered. In many cases the true conditions will be unknown or will be too complex to diagnose; so actual laboratory and mill trials must be relied upon. Because of the relatively high cost of wet-strength resins it is good business to select the proper resin for the job on hand and to make that resin perform at top efficiency.

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Received March 1, 1951. Presented at the Annual Meeting of the Technical Association of the Pulp and Paper Industry, New York, N. Y., Feb. 19–22, 1951.

The authors wish to acknowledge the contributions and assistance of A. L. Sinclair, J. P. Saxe, R. W. Lull, and A. F. Blockman. Permission of the American Cyanamid Co. to publish this material is greatly appreciated.

The Determination of Starch in Paper

K. M. BROBST and D. P. LANGLOIS

Starch can be removed quantitatively from paper by digestion with purified malt amylase. The enzyme appears to be specific and no interfering substances contaminate the starch extract. After hydrolysis of the extract the dextrose is measured and calculated as starch. The method has been tested on papers containing from about 0.6% to about 6% starch with easily duplicable results. Recovery of added starch was shown to be well over 90%—the extremes being 92.1 and 101.7%.

The problem of determining small amounts of starch in the presence of large amounts of extraneous materials is one that has commanded the attention of numerous investigators. The problem is an especially difficult one in that the starch is usually associated with other carbohydrates such as cellulose, hemicellulose, pentosans, gums, mucilage, and even the hydrolytic products of starch itself, dextrose and dextrins. The methods of starch determination, therefore, are as numerous as the substances in which it occurs since special adaptations must be made to take care of the non-starch carbohydrate portion of each material.

In general, the methods divide themselves into two groups: (1) the starch is separated from all interfering substances and determined separately in the extract, and (2) the starch is determined in the presence of the other carbohydrate constituents under conditions in which the latter do not interfere. An excellent review of the methods is given by Sullivan (*1*) in a recent article.

The determination of starch in paper is a special case of the general problem. Since it is difficult to determine starch in the presence of cellulose without considerable interference from the latter substance, methods of group (1) are usually employed. Once the starch has been removed from the cellulose it is not difficult to measure quantitatively. This can be done either by hydrolyzing it to dextrose and measuring the dextrose by some standard method or by forming the

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starch-iodine complex and determining the latter colorimetrically. Simerl (*2*) has recently published an excellent treatise on this colorimetric determination.

By far the most difficult step in the procedure is the complete removal of starch from cellulose. At least one fraction of the starch, viz., amylose, is so tightly adsorbed that it is practically impossible to remove it simply by washing with water even at 100°C. Pucher and Vickery (*3*) and Sullivan (*4*) dissolve the starch from the woody matter of trees by means of calcium chloride solutions but the method does not work quantitatively for the removal from paper. More recently Dijk (*5*) recommends the removal of starch by solution in boiling 2.5% acetic acid. Specifically he proposes it as a means of separating starch from mannan in paper.

Removal of the starch from the paper can be effected by hydrolysis with HCl. However, since cellulose is also a carbohydrate, if conditions are used which are drastic enough to hydrolyze all of the starch some cellulose is likely to be hydrolyzed. Under less drastic conditions all of the starch is not removed. This leads to uncertain results.

Enzymes have also been used as a means of solubilizing starch and removing it from cellulose and other carriers. This idea has the advantage that if the proper enzyme be selected only starch and no other carbohydrate will be hydrolyzed.

Malt enzymes were probably the first to be used but, in general, are not reliable. More recently fungal enzymes have been investigated by Denny (*6*) and Lehmann (*7*) who report complete recovery of starch from woody material. Sullivan (*4*) objects to these enzymes on the basis of their lack of specificity.

Tottingham (*8*) in his work recommended the use of salivary diastase which apparently has a greater specificity for starch than most diastatic enzymes. This idea forms the basis of the official method of starch determination recommended by TAPPI. Unfortunately salivary enzyme is not readily available and has to be prepared by the operator. The method of obtaining it is long and tedious and the quality of the product, to say nothing of its uniformity, is always in question. Hanes (*9*) has recommended a combined acid and malt β-amylase extraction which appears to be fairly reliable but it requires extra time due to the double extraction.

Recently purified malt enzymes have come to our attention and an examination has shown that they can be used very effectively for starch removal from paper with no danger of cellulose hydrolysis. Readily duplicable results can be obtained consistently. The advantage of using the purified malt enzyme is that only the starch is solubilized and that completely. No interfering substances appear with the starch in the extract so the latter can be hydrolyzed with acid and the resulting dextrose will give a direct measure of the starch. The method is rapid, needs no special apparatus and requires no special precautions on the part of the operator.

EXPERIMENTAL

Apparatus

A Waring Blendor equipped with a stainless steel microhead is used in the preparation of the sample.

Reagents

A. Fehling's Solutions (Soxhlet modification).

Solution A. Dissolve 69.3 grams of reagent grade $CuSO_4 \cdot 5H_2O$ in water and dilute to 1 liter.

Solution B. Dissolve 346 grams of Rochelle salt and 100 grams NaOH in water and dilute to 1 liter.

Allow to stand 2 days and filter through prepared asbestos.

Mix equal volumes of A and B immediately before use.

B. Asbestos for Gooch Crucibles. Prepare according to TAPPI Standard method (*10*).

C. Amylase Suspension. Paste 0.1 gram of purified malt amylase in 1 to 2 ml. water and dilute with stirring to 100 ml. Prepare fresh daily.

The amylase used in these tests was obtained from the Bjorksten Laboratories, 323 W. Gorham St., Madison, Wis., but any purified malt amylase will be suitable.

Test Specimen

Weigh 1 gram of paper to the nearest 1 mg. and transfer to the Waring Blendor along with 50 ml. water. Agitate for 1 to 2 minutes or until the paper is thoroughly disintegrated. Transfer to a 250-ml. beaker using two 25-ml. portions of water to effect complete removal of the pulp from the Blendor.

Determine the moisture in the test specimen according to TAPPI Standard T 412 m, using a separate sample weighed at the same time as the specimen for the starch determination.

Procedure

Place the beaker containing the disintegrated specimen in a steam bath and heat for 15 minutes with occasional stirring. Cool to 60–65°C. and add 10 ml. of the enzyme solution from a volumetric pipet. Place in a water bath at 60°C. and hold at this temperature for 30 minutes.

Remove the sample from the water bath, heat just to boiling, and filter with suction through a 5.5-cm. Buchner funnel using Whatman No. 1 paper. Wash the pulp with three 20-ml. portions of hot (90°C.) water, each portion of wash water being added first to the beaker originally containing the sample. Scrape the sides of the beaker with a rubber policeman during the transfer and washing process in order to effect complete transfer of the sample to the filter.

Place the filtrate and washings in a 250-ml. Erlenmeyer flask, add 5 ml. of concentrated hydrochloric acid, and boil under reflux for 2 hours. At the same time set up a blank consisting only of 10 ml. of the enzyme solution, 150 ml. water, and 5 ml. concentrated hydrochloric acid.

At the end of the refluxing period cool the samples in an ice bath to well below room temperature, add 3 drops of 0.2% methyl red indicator, and neutralize to a faint pink by the addition of 5 *N* sodium hydroxide from a buret. Transfer the neutralized solution to a porcelain evaporating dish and evaporate on a steam bath to about 30 ml. Filter if necessary to remove adventitious particles and dilute to 40 ml. in a 50-ml. graduate. Transfer the 40 ml. of solution to a scratch-free 400-ml. beaker rinsing the graduate with

Table I. Reproducibility of Results

Sample	Cu_2O, mg., (net)	Dextrose, mg.	starch, mg.	starch, %	Average % starch	Deviation from average	% Deviation from average
1	16.0	6.6	5.9	0.59		−0.01	−1.7
1	16.6	6.8	6.1	0.61	0.60	+0.01	+1.7
2	51.9	22.2	20.0	2.00		−0.02	−1.0
2	53.1	22.7	20.4	2.04	2.02	+0.02	+1.0
3	62.5	26.8	24.1	2.41		−0.03	−1.2
3	64.7	27.6	24.8	2.48		+0.04	+1.6
3	64.0	27.4	24.7	2.47		+0.03	+1.2
3	62.7	26.9	24.2	2.42		−0.02	−0.8
3	62.3	26.7	24.0	2.40	2.44	−0.04	−1.6
4	142.6	62.5	56.3	5.63		+0.01	+0.2
4	143.3	62.8	56.5	5.65		+0.03	+0.5
4	141.6	62.0	55.8	5.58	5.62	−0.04	−0.7

10 ml. of water which is added to the main filtrate. Determine the dextrose present by the Munson-Walker method according to the directions of the Association of Official Agricultural Chemists (*11*). Subtract the weight of cuprous oxide contributed by the blank from the total cuprous oxide precipitate obtained from the paper samples. From the net weight of cuprous oxide determine the amount of dextrose according to the Munson-Walker tables. Multiply the amount of dextrose by 0.9 to find the amount of starch present in the sample. Report the amount of starch on a moisture-free paper basis to the nearest 0.1%.

DISCUSSION

The method was applied to a number of paper samples of varying starch content (Table I). Starch percentages were calculated to hundredths of a per cent to better illustrate the precision of the method. Calculations are all on a nondry basis to avoid superfluous data. The results show a maximum deviation from the average of ±1.7% even when a large number of replicates are run. The deviation does not appear to be much higher for the papers with low starch content than for papers with high starch content. For greatest precision, however, the sample of paper should contain over 20 mg. of starch.

To test the efficiency of the single enzyme treatment some of the samples in Table I were given a second enzyme extraction. Results are given in Table II. As the net weights of cuprous oxide fall outside the Munson-Walker table only an estimation of the amount of starch removed by the second extraction can be obtained. Assuming a linear relationship between cuprous oxide and dextrose in the 0 to 10-mg. cuprous oxide range, 1 mg. cuprous oxide is equivalent to 0.4 mg. dextrose, and the values in Table II are obtained. These values are quite erratic which may be due entirely to manipulation error. However, they are also small as compared to the total starch removed, and

Table II. Second Enzyme Treatment—Efficiency of Enzyme Treatment

Sample	Cu_2O, mg. (net)	Dextrose, mg.	Starch, mg.
1	3.3	1.3	1.2
1	1.0	0.4	0.4
2	4.3	1.7	1.5
3	5.5	2.2	2.0
3	2.1	0.8	0.7
4	0.9	0.4	0.4
4	0.7	0.3	0.3

Table III. Recovery of Starch Added to Pulp

Sample	Cu_2O, mg. (net)	Starch added (d.s.b.), mg.	Starch found, mg.	% recovery
1	45.7	18.5	17.6	95.1
2	88.8	35.2	34.5	98.0
3	79.5	30.3	30.8	101.7
4	70.5	27.5	27.3	99.3
5	61.0	23.2	23.5	101.3
6	61.2	24.3	23.6	97.1
7	45.7	18.5	17.6	95.1
8	55.8	23.2	21.4	92.3
9	60.8	25.4	23.4	92.1
Average				96.9

indicate that over 90% of the starch is removed by a single enzyme treatment.

The data in Table II also show that there is not necessarily any relationship between initial starch content of a paper and the efficiency of a single enzyme extraction.

For work of the highest accuracy a second enzyme extraction should be used or at least the completeness of the first extraction should be tested on the particular type of paper under investigation. For routine work on a fixed type of paper one enzyme treatment should be satisfactory.

The recovery of starch added to pulp was used to illustrate the accuracy of the method. Known weights of corn starch were added to starch-free pulps suspended in water and the whole carried through the single enzyme extraction procedure. The results are given in Table III. Samples 1 to 6 were made from the paper used in the previous experiment. A triple enzyme digestion was used to insure complete removal of the starch. Samples 7 to 9 were straight pulps. The values obtained show variations from the theoretical recovery of from +2% to −8% over the entire range of starch content used. This suggests that not all of the starch is removed every time by a single extraction but that a greater than 90% recovery can be assured each time. Only two of the results exceed 100% which leads us to believe that they are manipulation errors.

On the basis of the tests made purified malt amylase may be used to remove the starch quantitatively from paper. Readily duplicable results are obtained. A single enzyme digest removes over 90% of the starch with the average being 96.9%. The rapidity of the method makes it especially adaptable to routine analyses.

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Received Feb. 17, 1950.

ASSOCIATION NEWS AND EVENTS

Alkaline Pulping Conference

The Alkaline Pulping Committee of the Technical Association of the Pulp and Paper Industry is now arranging a 3-day conference to be held on Sept. 26–28, 1951, at the John Marshall Hotel, Richmond, Va.

The technical program will feature "Wood Preparation and Cooking for the Sulphate and Semichemical Processes." In addition, papers will be presented dealing with Tall Oil, Bark Burning, and Lime Recovery.

Mill visits are scheduled for September 28.

A large attendance is expected. Reservations should be made by writing direct to the John Marshall Hotel, Richmond, Va. The TAPPI Alkaline Pulping Conference should be mentioned in making reservations.

Henry Vranian, Chesapeake Corp. of Virginia, West Point, Va., will be General Chairman of the Conference. R. R. Fuller, Gulf States Paper Co., Tuscaloosa, Ala., will be program chairman. A. P. Yundt, Camp Manufacturing Co., Franklin, Va., will have charge of registration. C. R. Outterson, Albemarle Paper Co., Richmond, Va., will take care of publicity. G. R. Tennant, Continental Can Co., Hopewell, Va., will have charge of transportation.

The membership of the Alkaline Pulping Committee is as follows:

Henry Vranian, Chesapeake Corp. of Virginia, West Point, Va., *Chairman.*
K. D. Running, Halifax Paper Co., Roanoke Rapids, N. C., *Secretary.*
P. B. Borlew, Container Corp. of America, Fernandina, Fla.
K. G. Chesley, Crossett Lumber Co., Crossett, Ark.
G. L. Clarke, Kimberly-Clark Corp., Neenah, Wis.
R. R. Fuller, Gulf States Paper Co., Tuscaloosa, Ala.
J. J. Goss, Gaylord Container Corp., Bogalusa, La.
K. M. Guest, National Container Corp., Jacksonville, Fla.
E. A. Harper, Hudson Pulp & Paper Co., Palatka, Fla.
F. L. Jones, St. Joe Paper Co., Port St. Joe, Fla.
W. P. Lawrence, Champion Paper & Fibre Co., Hamilton, Ohio
R. H. Stevens, National Container Corp., Jacksonville, Fla.
M. L. Taylor, Union Bag & Paper Corp., Savannah, Ga.

1951 Empire State Annual Meeting

The annual meeting of the Empire State Section of the Technical Association will be held on June 27–30, 1951, at Whiteface Inn, Lake Placid, N. Y.

"The Future of the Paper Industry in New York State" will be the theme of the meeting.

Reservations for rooms should be made with Henry W. Haynes, Managing Director, Whiteface Inn, Lake Placid, N. Y.

1952 Empire State Annual Meeting

Note the dates and do not confuse them with the preceding announcement. A preview, demonstrating the enthusiasm of the incoming administration of the Empire State Section, is the announcement a year or more in advance of the 1952 annual meeting of the Empire State Section. Several meetings of the Convention Committee have been held, and this is to announce that the 1952 annual meeting will be held jointly with the Niagara Branch of the Technical Section of the Canadian Pulp and Paper Association on June 19–21, 1952, at the General Brock Hotel, Niagara Falls, Ont.

J. S. Reichert of E. I. du Pont de Nemours & Co., Inc., Niagara Falls, N. Y., will serve as General Chairman with Stephen G. Stapley of the Provincial Paper Co. Ltd., Thorold, Ont., and I. V. Earle of the Upson Co., Lockport, N. Y., serving as Co-Chairmen.

New England 1951 Annual Meeting

The annual meeting of the New England Section will be held on June 8–9, 1951, at the Griswold, Groton, Conn. The meeting will be devoted to a consideration of "Statistical Quality Control as Applied to Paper Manufacturing and Converting."

Registration will begin at 10 a.m. Friday, June 8.

A luncheon will be held at noon (the speaker to be announced).

In the afternoon talks will be given by Howard Coughlin, Thompson Products Co., Cleveland, Ohio, and Geoffrey Beall, University of Connecticut, Storrs, Conn. This will be followed by the annual meeting for the election of officers.

There will be a dinner at 7 p.m. on Friday.

On Saturday morning there will be a panel discussion on "Statistical Quality Control."

The members of the panel will be:

Geoffrey Beall, University of Connecticut, Storrs, Conn.
Howard Coughlin, Thompson Products Co., Cleveland, Ohio.
F. S. Klein, Byron Weston Co., Dalton, Mass.
M. E. Blew, Strathmore Paper Co., W. Springfield, Mass.
H. W. Knudson, Hollingsworth & Vose Co., E. Walpole, Mass.
O. H. Somers, Western Printing and Lithographing Co., Poughkeepsie, N. Y.
W. R. Purcell, Brown Co., Berlin, N. H.
M. S. Renner, Dewey & Almy Chemical Co., Cambridge, Mass.

The meeting will end with the luncheon on Saturday. Golf facilities will be available on Friday morning and Saturday afternoon.

Sixth Engineering Conference of the Pulp and Paper Industry

Plans are under way toward the organization of the Sixth Engineering Conference of the Pulp and Paper Industry to be held at the General Oglethorpe Hotel, Savannah, Ga., on Oct. 15–18, 1951. This meeting is sponsored by the Committees of the TAPPI Engineering Division of which George H. Pringle, Assistant Chief Engineer of the Mead Corp., Chillicothe, Ohio, is General Chairman, and J. W. Hemphill of the Johns-Manville Corp., New York, N. Y., is General Secretary.

This preliminary announcement is made to urge engineers of the pulp and paper industry to make reservations at the General Oglethorpe Hotel as early as possible and to arrange for railroad transportation at an early date. The latter is quite necessary since the Engineering Conference dates coincide with the dates of the American Legion Convention to be held in Miami, Fla. For members traveling by way of New York City the Atlantic Coast Line advises that the West Coast Champion will leave New York daily at 3:25 p.m., arriving at Savannah at 6:50 a.m., leaving Savannah at 9:25 p.m. and arriving at New York at 12:30 p.m. The round-trip fare, New York to Savannah and return, is $59.10 plus $8.87 Federal tax. A roomette costs $10.85. From the Middle West, the route would be Louisville and Nashville

R. R. or the Southern R. R. from Cincinnati to Savannah via Atlanta.

Following are some of the papers to be presented:

Steam and Power Sessions

"Materials and Design of Piping Systems for High Pressure, High Temperature Service."
"Gas Turbine Applications in the Paper Mill," by W. C. Bloomquist, General Electric Co., Schenectady, N. Y.
"Cinder Collection."
"Education of Power Plant Operators."

Engineering Research and Machine Design Sessions

"A Study of the Calender," by Eli Cowan, Consulting Engineer, Montreal, P. Q.
"Capacity of Thickeners," by Robert A. Nivison, Improved Paper Machine Corp., Nashua, N. H.
"Centralized Control of Stock Systems."
"A Study of the Hardness of Rubber Covered Rolls and the Effect of Water Removal."
"Machine Design Data."
"Methods for Quickly Estimating Costs of Engineering Projects."

Electrical Engineering Sessions

"Report on Power Requirements of the Paper Machine Sections," by W. Mikelson, General Electric Co., Schenectady, N. Y.
"Application of Cables in Pulp and Paper Mills," by A. O. Mortenson, St. Regis Paper Co., Pensacola, Fla.
"The Power Requirements for Press Sections of Paper Machines," by R. R. Baker, Westinghouse Electric Corp., E. Pittsburg, Pa.

Mill Design and Economic Aspects Session

"Pump Difficulties in Paper and Pulp Mills," by Parkman A. Collins and J. G. Rearick, Warren Steam Pump Co., Warren, Mass.
"Investigation of the Vacuum Drop-Leg Problem," by George R. Wadleigh, Consulting Engineer, New York, N. Y.
"Mill Engineers' Selection of the Paper Machine Drive," by Roland A. Packard, Consulting Engineer, S. Hadley Falls, Mass.

Materials Handling Session

"Log Transfer."

Mill Maintenance and Materials Session

"Lubrication of Paper Mill Machinery."

Chemical Engineering Session

"Report of the Digester Corrosion Committee."

Subsequent issues of *Tappi* will contain further details of the Engineering Conference Program.

TAPPI Corrugated Containers Conference

The first general conference to be sponsored by the Corrugated Containers Committee of the Technical Association of the Pulp and Paper Industry will be held at the Statler Hotel, Cleveland, Ohio, on May 18, 1951. It will be devoted to a consideration of "Corrugated Combining Operations."

F. D. Long, Technical Director of the Container Corp. of America and Chairman of the Corrugated Containers Committee will preside as Moderator.

The morning session, beginning at 9:30 a.m. will feature the following presentations:

"Theoretical and Actual Strength Qualities of Corrugated Board," by R. C. McKee, Institute of Paper Chemistry, Appleton, Wis.
"Present Operating Problems and Future Hopes of a Corrugated Container Plant Superintendent," by R. T. Cassady, Vice-President, The Jackson Box Co.

The afternoon program will include the following papers:

"Past, Present and Future Design of Corrugated Combiners," by Walter J. Goettsch, Vice-President, Samuel M. Langston Co., Camden, N. J.
"Theoretical Problems of Heating and Drying," by A. F. Montgomery, Vice-President, J. O. Ross Engineering Co., Chicago, Ill.

The dinner program will be featured by a speaker (to be announced) who will talk on "TAPPI and the Converting Industries."

The ceremony of presenting the Charter of the Lake Erie Section, co-sponsor of the Conference, will feature addresses by K. P. Geohegan, Vice-President, The Howard Paper Mills, Inc., and President of TAPPI and R. G. Macdonald, Secretary-Treasurer of the Technical Association.

Any one planning to attend the Conference will be welcome as a visitor to the Cleveland plants of Hankins Container Co. and the Robert Gair Co.

Second TAPPI Coating Conference

The Second Conference to be sponsored by the Coating Committee of the Technical Association of the Pulp and Paper Industry was held at the Hotel Statler in Boston, April 18–20, 1951. As with the First Conference which was held in Grand Rapids, Mich., two years ago, the Second was very successful in regard to both quality of program and in attendance, the total registration being 284. It is expected that all the papers given will appear in the forthcoming issues of *Tappi*, consequently this report will but indicate the tenor of the program.

Coating Raw Stock Symposium

The meeting was opened by A. D. Bonanno, Champion-International Co., Lawrence, Mass., General Conference Chairman, who introduced R. T. Trelfa, Hercules Powder Co., Wilmington, Del., the chairman of the Raw Stock Symposium. The first speaker, Norman I. Bearse, Champion-International Co., informally presented an introduction by reviewing the history of paper coating and indicating the problems involved. One of the purposes of the Raw Stock Symposium was to collect information which eventually will be combined into a TAPPI monograph on the subject. Each of the following speakers was approached by the program committee because of his knowledge of his particular specialty, and others will be added so that in its final form the monograph will cover authoritatively all phases of paper and board coating.

Seated, l. to r.: A. Lewenstein, R. T. Trelfa, A. D. Bonanno, B. H. Wright
Standing, l. to r.: P. J. Thoma, P. Hansen, J. T. Loomer, T. LaHaise, J. E. Wilber

Thomas LaHaise of the Imperial Paper and Color Corp., Plattsburg, N. Y., discussed the raw stock requirements of hanging papers by first setting up specifications based on his company's converting experience and then elaborating on the various items. Weight is, of course, important in that it affects the wallpaper rollage per ton. The requirements of the wallpaper printer and the paperhanger demand close control of the tear factor and the porosity of the sheet, the first being influenced by the sulphite content, the second by the quality of the groundwood. Sizing affects both converting operations as well as subsequent hanging. Another point of particular interest is the control of oil and slime spots that are difficult to detect until after coating and printing and which

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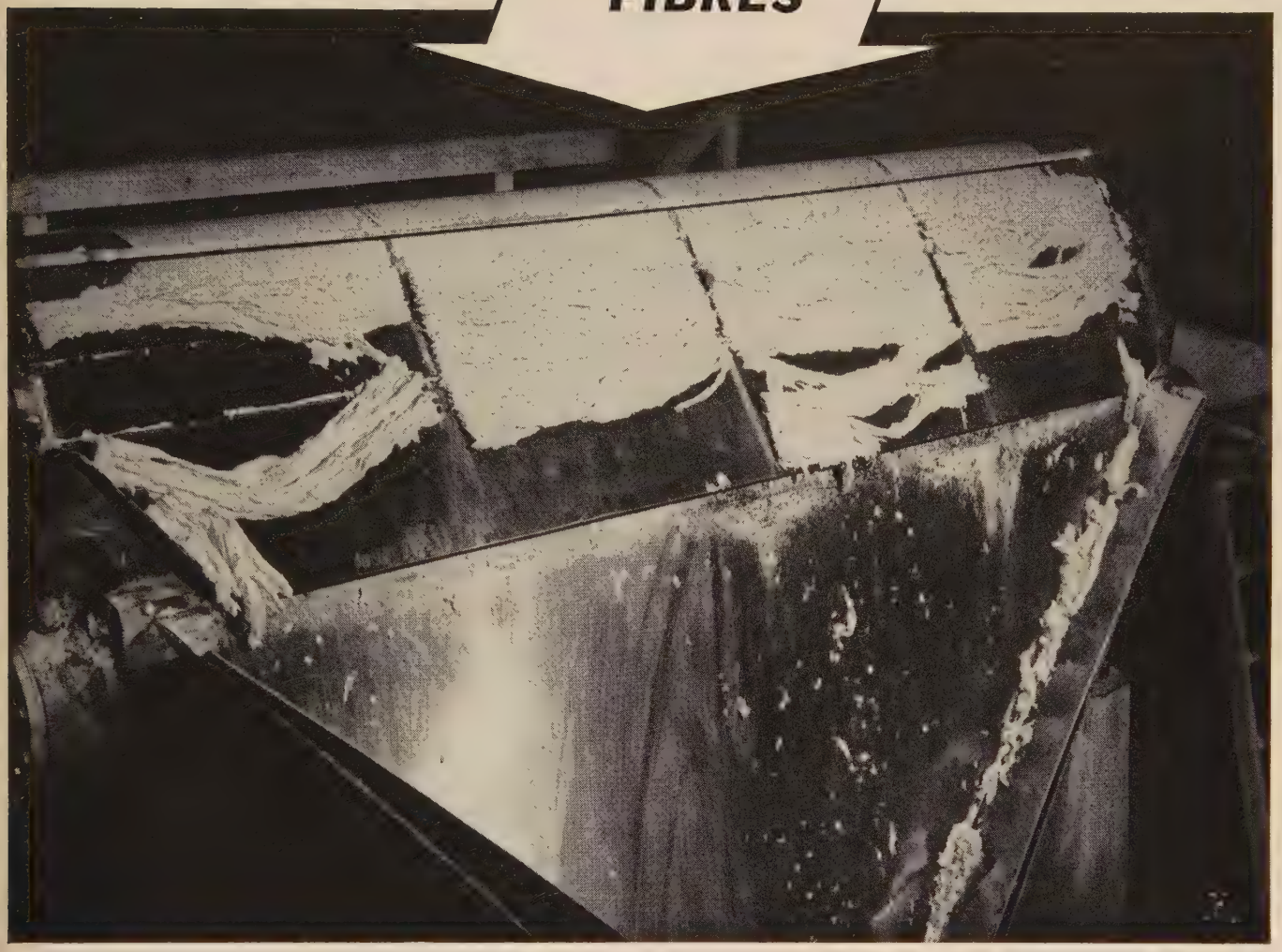

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result in spoilage of finished goods. It was stressed that the specifications outlined were the results of but one mill's experience but that conformance had been found to give a satisfactory hanging stock.

The second paper, "Requirements for Off-Machine Board," was read in the absence of A. T. Luey, Sutherland Paper Co., Kalamazoo, Mich. The factors were under two heads, appearance and functional qualities. Cleanliness, brightness, formation, and smoothness, are characteristics that affect the quality of the coated board and influence the weight of coating which must be applied for satisfactory coverage. Off-machine coating usually involves heavier coating weights than on-machine, an economic advantage since the coating is usually less costly than high quality pulp. The coating and the sheet must be uniform and have such characteristics so that the board will have good bending properties.

Off-machine book paper raw stock requirements were covered in a paper by A. Lewenstein, Appleton Coated Paper Co., Appleton, Wis., and Paul Hansen, Bergstrom Paper Co., Neenah, Wis. Of the three elements that enter into paper coating, the machine, the coating, and the raw stock, the last can be the most troublesome in that it is the hardest to control and hold uniform. The properties of the raw stock of importance are: the ability to lay flat throughout the coating process, freedom from curl, ability to take a level continuous coating, present an acceptable surface from the standpoint of the adhesive bond, have good brightness, and finally have sufficient strength that it will not break during the coating operation or split due to ink tack during the subsequent printing operations. The authors reviewed the literature and discussed the various points mentioned stressing the point that there are many differences in opinion on the usefulness of the tests now used to evaluate raw stock. Basis weight gives evidence of a uniform sheet and opacity variability gives a good indication of variations in weight. They may not indicate such conditions as will cause the sheet to curl when wetted, but may be worthy of further investigation. A good stock is one that is uniformly and evenly wetted, and as faulty paper is difficult to detect prior to coating operations it opens a wide field for investigation. Also of importance is the bond between the coating and the sheet as well as the strength of the sheet itself. Migration of the adhesive constituent of the coating is generally cited as the cause of failure of the coating-paper bond. The authors have found that density and sizing do not correlate well to the nature of the bond obtainable.

The requirements and processes involved in the production of a high-grade, machine-coated board using an offset intaglio roll coater were discussed by Joseph T. Loomer, Robert Gair Co., Uncasville, Conn. Printing and end use requirements of board dictate a different approach to coating techniques over those as used in the machine coating of paper. The inherent qualities of paperboard and its manufacture has led to the use of one coating formula for all grades of printing. One process now in use involves the application of glyoxal in starch or water solution to the top surface of the board at the breaker stack calenders, applying a protein adhesive coating, subsequent drying in which the coating becomes waterproof, then treating at the finishing calenders with water or different finishing solutions to print flat or gloss ink. The use of this method permits low adhesive to pigment ratios in the coating color since the water-box solutions control printability and wax pick. Furthermore, great flexibility of operation in line with normal board mill practices is obtained.

J. E. Wilber of the St. Regis Paper Co., Deferiet, N. Y., was next on the program and indicated the requirements for on-machine book raw stock stressing that the purpose of his paper was to stimulate further interest in the properties which have the greatest bearing on the finished sheet. Of primary interest is the internal strength of the raw stock which must be sufficient to prevent splitting and rupturing during the printing process. Brightness, color, smoothness, and dimensional stability must also be considered. Prevention of adhesive migration is a problem involving both the papermaker and the coating formulator. A low wax pick test and a low bursting strength invariably indicate a tendency for the sheet to split during printing. An economical balance must be established between the use of high brightness pulps in the raw stock and high brightness pigmentation of the coating. Dirt must be kept at a minimum in that the high brightness and finish of book papers present a greater contrast making them that much more objectionable.

Paul J. Thoma, Time, Inc., Springdale, Conn., listed the properties desirable in raw stock for coated publication papers. Sufficient long fiber should be used to maintain burst and tear but should be kept to a minimum for best formation. Sulphite is most commonly used for the long fiber because of its

The luncheon at the Second Coating Conference sponsored by TAPPI, Hotel Statler, Boston, Mass., April 21, 1951

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easy bleaching properties giving high brightness and its high strength, but some favor the use of kraft with the sulphite to provide further strength and elasticity.

The short fiber portion of the furnish should consist of soda, groundwood, or broke or a combination of the three. As much groundwood as possible should be used since it is inexpensive and more opaque and resilient than either long or short fiber chemical pulp. The groundwood should be free of excessive coarse and fine fibers since the coarse fibers float to the top of the sheet as it is formed and make a rough sheet; the fines slow drainage and produce a lacy top surface.

Fillers, such as clay or calcium carbonate, should be used to obtain brightness, to aid some in opacity, and to improve surface characteristics. Too much filler should be avoided since it leads to wax troubles. However, too little filler gives a poorly filled sheet and low densometer difficulties.

No sizing is necessary, the natural rosin in the wood provides ample sizing. Sometimes in the summer when the water is warm it is necessary to increase the amount of starch to properly bond the coating since increased binder penetration is experienced, together with a drop in wax on the raw stock. Starch in the beater is frequently used to decrease the tendency for "stock lift" on the printing presses.

Alum is sometimes used for pitch control and to prevent sticking on the presses.

The raw stock should possess a smooth surface with the texture as fine as possible consistent with strength requirements. The formation should be good, the fibers well distributed to prevent streaks, lumps, or fiber clots in the sheet. A poor formation smoothed out by calendering produces a sheet varying in density at various spots resulting in a printed coated sheet with a bubbly appearance. Accompanying this will be a variation in ink receptivity over the sheet.

The elongation and elasticity should be sufficient to withstand occasional excessive stresses in coating and supercalendering, to handle the shrinkage experienced in the printing press drier, and to resist the punishment of printing.

The moisture content and absorbency should be uniform across the web. The absorption rate should be high for the coating vehicle for rapid setting of the coating before contact with a drier surface.

The compressibility and resiliency of the sheet should be high to provide a cushioning action when the sheet is printed.

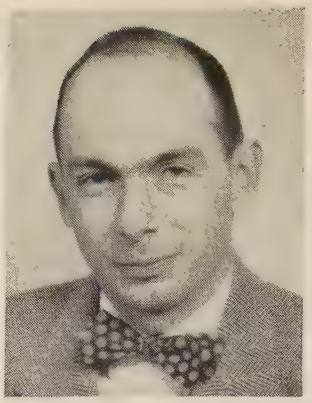
The basis weight and caliper should be uniform.

The sheet should possess sufficient machine direction tensile to withstand tension in coating and printing and especially the tension that develops in the printing press drier as the sheet shrinks. The cross machine direction tear and dry tear should be high enough to prevent web breaks during supercalendering, winding, printing, and dehydration during passage through printing press drying sections. The folding endurance should be high enough to prevent cracking. The pick should be high for four color work. Of secondary consideration in strength are burst, machine and dry tear, and cross tensile.

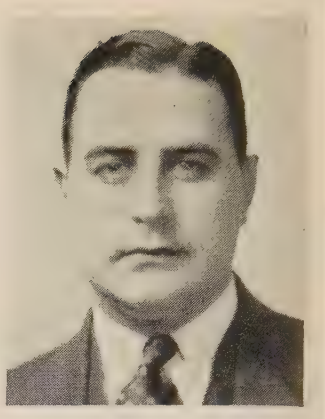
The sheet should have a high brightness and opacity. Wood dirt and process dirt should be kept to a minimum. The fading resistance should be as high as possible. The shade should be maintained as near standard as possible.

The raw stock should be free of odor. The pH should be as near the neutral point as possible to maintain the coating dispersion at the interface and to prevent loss of strength incident to drying and passage through heat drying printing presses.

The last paper on Wednesday's program was given by Bruce H. Wright, Crown Zellerbach Corp., West Lynn, Ore., "The Influence of Pulp Characteristics on Printing Papers." The influence of pulp and individual fiber characteristics on the printability of coated magazine papers was discussed. Special attention was given to the need in furnishes for this grade using fibers which are as short and narrow as possible



R. T. Trelfa, Chairman, Coating Raw Stock Symposium



A. D. Bonanno, Program Chairman, Second Coating Conference

within the limits of strength requirements, thus providing good surface continuity and formation, contributing to higher smoothness and better prints. Photographs of supercalendered handsheets of the fiber fractions of several pulps show that printability is improved as fiber length decreases. In the same series compressibility decreases with decreasing length indicating that smoothness masks the effect of compressibility except when the surfaces are equally smooth. In such cases the more compressibile pulp will have better printability. The effects of pulp uniformity, resilience, opacity, strength, and ink absorption were also considered. The paper stressed the advisability of using component pulps to better advantage rather than placing too much emphasis on subsequent operations in obtaining good print quality.

General Sessions

The Thursday Session was opened by A. D. Bonanno of the Champion-International Co., who introduced A. Ronald Trist of the Trist Colloid Products Patented, New York, N. Y. The Trist process is a new system of coating paper at great speed that has been brought about by the discovery of a new colloidal process for the dispersion of both solid and liquid substances with the result that a new type of emulsion has been created and perfected. It is a nonwater wetting, waterproof coating initially consisting of resins, pigments, etc., which have been dissolved and dispersed in petroleum or some other solvent.

The coating composition itself is in reality a three-phase emulsion suspending pigment, such as calcium carbonate, lithopone, barium sulphate, magnesium silicate, as well as many other pigments which may be of any color. No absorption takes place below the face or surface of the paper. The phenomenon results in part from the peculiar electrophysical characteristics of the emulsion.

An especially constructed enclosed type of colloidal machine has been invented to obtain the very small particle size desired to make the emulsion or coating. These particles can be of half a micron or less.

A special high-speed machine to apply the coating had to be designed also. This machine can be built to coat paper of any width. It is made to coat, dry, and reel a web of paper at any speed up to 3500 lineal feet per minute.

The coating composition, colloidal machine (or mill), and the high-speed coating machine jointly comprise the essential features of the Trist paper coating system.

This was followed by a paper by C. G. Albert, Edgar Bros. Co., McIntyre, Ga., "Particle Structure and Flow Properties of Coating Clays." Some of the recent information concerning the particle structure of kaolin clays was presented, together with experimental data with regard to the effect of size and nature of particles upon the flow of suspensions. Based upon starch coating colors of relatively high solids content, some of the rheological effects of changes in particle size dis-

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M-27-X has been tested, proven and accepted by leading paper manufacturers. Now, with greatly augmented production, M-27-X is offered to the entire paper industry.

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tribution and particle structure as well as the deflocculating procedure were shown by means of experimental data. These data include measurements of viscosity at different rates of shear together with information on the thixotropic behavior of the coating colors considered.

The third paper, "The Mechanism of Gloss Development in Clay Coated Sheets," by L. A. Woodward, Assistant Professor of Physics, Faculty Research Association, Georgia Tech Experiment Station, Atlanta, Ga., and S. C. Lyons, Georgia Kaolin Co., Dry Branch, Ga., discussed the results of their findings on the structure of clay and the effect of clay on coating. Previously it was believed that they were hexagonical plates of varying thicknesses. It was found that the larger plates were rather cemented, stacked aggregates of small single plate crystals that are below 2 mm. in diameter. Larger sizes are aggregates. The larger the proportion of the small particles, the greater the increase in gloss.

The luncheon was held Thursday noon, April 19. K. P. Geohegan, President of TAPPI; Vice-President, Howard Paper Mills, Inc., Dayton, Ohio, intended to be present to greet the group in the name of the Association but was unable to do so. J. H. Heuer, A. P. W. Products, Inc., Albany, N. Y., Chairman of the TAPPI Coating Committee, acted as Toastmaster and introduced George Olmsted, Jr., President of the S. D. Warren Co. Mr. Olmsted's speech, "Feast or Famine," is printed in this issue of *Tappi*.

The first paper after the luncheon was given by F. Masterman, "A Study of Particle Size, Its Determination and Effects." When variations in coating were experienced, it was believed that a more extensive study on the particle size of clay was in order. By using a centrifuge, an extensive study was conducted and his procedure was described in detail by Mr. Masterman. After analyzing several clays, coating mixtures were made and tested for brightness, gloss, pick, and several other coated paper properties. It was found that as the particle size decreased, gloss, brightness, adhesive demand, and opacity increased.

The paper by J. Frankewicz and J. Senuta, Champion-International Co., Lawrence, Mass., "Method of Predicting Brightness and Opacity of Coatings," stated that the final brightness of coated paper is dependent on the brightness of the raw stock and the brightness of the coating color. The latter is dependent upon the pigments used and the adhesives required, and their proportions. However, with particular pigmented formulas maximum brightness and opacity are obtained at a definite coat weight, dependent on the basic properties of the pigment in regard to their hiding power and brightness. With knowledge of the basic properties of the pigment and adhesives, advantage can be utilized in obtaining maximum efficiency of coating at different degrees of raw stock brightness.

Friday's General Session was opened by Chairman Bonanno who introduced W. H. Bureau, Butler Paper Co., Chicago, Ill. In his paper, "The Requirements of Coated Paper for Offset Lithography," Mr. Bureau mentioned that offset plate making and inks, beginning in the thirties, have been greatly improved but because of the public's reception of color work, printers became more interested in letterpress printing and especially so since the coated papers were not too satisfactory for offset work. Offset printing gives a thinner film and because of contact of the plate with the sheet, dimensional stability is a paramount requirement. This must be coupled with good bonding in that the coating will be weaker when it is moistened and offset inks have more tack than letterpress. It is essential that the surface of the sheet be perfectly level, that it be clean, and that it does not have any adverse effect on the printing plate. Mr. Bureau stated that offset lithography appears to be becoming increasingly important in regard to usage of coated papers and that continued efforts to improve the sheet are worthy of the extended efforts of the coaters.

The second paper of the Friday session "A Preliminary Comparison of Starches and Dextrines in Paper Coating" was given by Gordon I. Hoover, Provincial Paper Ltd., Georgetown, Ont. Mr. Hoover stressed that his was definitely a preliminary report and that it was offered as a starting point for a discussion. Tests were made on a number of varieties of starch and the viscosity patterns were studied. By watching the rheological characteristics, it was possible to improve mill operating conditions.

The last paper, "The Hercules Print Tester," was presented by E. J. Barber and J. W. Davis, Hercules Powder Co., Wilmington, Del., describing an instrument that has been developed for measuring the pick resistance of mineral-coated printing papers. The instrument embodies the basic principles of a printing press. Small strips of the test specimen are printed with an inklike material under controlled conditions. The speed of printing is increased by small increments until picking of a test strip occurs.

Factors affecting test results obtained with the instrument are: (1) speed of printing, (2) ink tack, (3) ink temperature, (4) ink volume, and (5) impression pressure. Speed of printing provides the principal means for varying the stress to which the test sample is subjected. Ink tack can also be varied conveniently to extend the stress range. Ink temperature is held constant. Ink volume and impressure pressure are adjusted to produce a good quality solid print on the test strip. An examination of operating variables and a description of operating procedure are included.

LETTERS TO THE EDITOR

Origin of the Yankee Paper Machine

The following exchange of letters is of historical interest.

To the Editor, *Tappi:*

I would be grateful if you could let me know when the M. G. (Yankee paper machine) was invented.

PETER FAICHNEY, *Pulp and Paper Lecturer*
College of Technology, Manchester, England

To the Editor, *Tappi:*

I understand that the Yankee machine was invented in this country, that it developed no acceptance here, that it was picked up by the German industry (which called it the Yankee), that after it became a success in Europe it was brought back to this country and upon so doing was designated as the "Flying Dutchman," and that gradually the name "Flying Dutchman" was discontinued and now the machine is commonly known as the Yankee. In all my reading, I do not recall ever having seen the name of the inventor of the machine or the actual date of the invention.

HARRY E. WESTON, *Secretary and Treasurer*
American Pulp and Paper Mill Superintendents Assoc.

To the Editor, *Tappi:*

We wish to advise you that the Yankee machine was invented in Germany in 1827 by the papermaker Jacob Oeschelhauser of Siegen, Westphalia, and patented in 1829. Oeschelhauser started the building of the paper machines in 1824. His original machines were extremely simple. They had a short wire, wet press, middle roll, and a larger drier, running without a felt. The entire machine was driven from the rigidly located middle roll. This roll served, at once, as top couch roll, top press roll, and drier pressure roll. A short pickup felt ran around it to take the sheet off the wire.

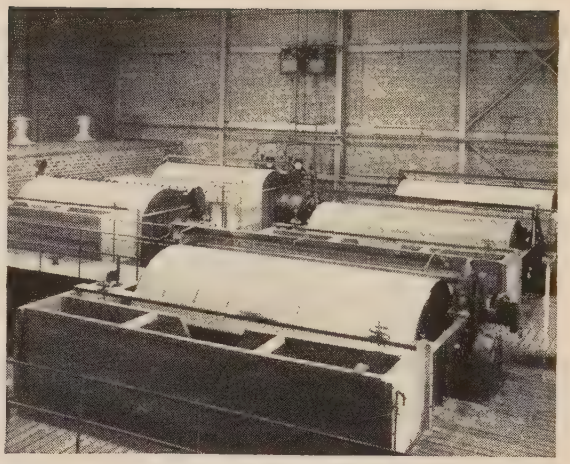
V. BERGMANN (RICHARD LANG)
J. M. Voith Co., Heidenheim, Germany

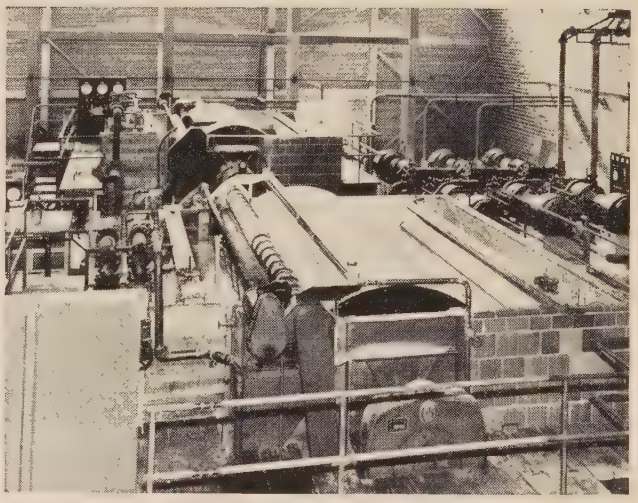
OLIVERS

*5 GROUNDWOOD DECKERS

key equipment at COOSA RIVER

*2 DECKER-SAVEALLS





All seven units are rubber-covered with stainless steel fittings!

Coosa River is a modern newsprint mill, an outstanding mill in the South and one of the finest in the country. While the selection of Olivers for the important filtration work at Coosa naturally is gratifying to us, we wish to call to your attention another factor: the step taken by Coosa to eliminate possibilities of corrosion and contamination. Specifications called for rubber covering and stainless steel fittings.

Newsprint mill trend is in that direction. For example, we recently received an order for 6 Olivers of similar design for the lastest newsprint mill being projected in the Western Hemisphere—the new mill at Duncan Bay, British Columbia

So here you have two of the outstanding modern newsprint mills of the world: far apart geographically; both selecting Olivers for the important filtration work; both ordering corrosion-resisting construction. This should be of interest to every newsprint mill.

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Hobart Duff Pty., Ltd.
Melbourne

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Johannesburg, Transvaal

PERSONAL MENTION

Items About New and Old Tappimen

New TAPPI Members

Romano Aldo, Manager, Fertrinelli Masonite S.p.A., Bolzano, Italy.

Yukio Arisawa, Director, Technical Research Section, Kokoku Rayon & Pulp Co. Ltd., Tokyo, Japan, a 1931 graduate of Tokyo University.

Raymond H. Atwood, Graduate Student and Assistant Instructor, University of Maine, Orono, Me., a 1947 graduate of the University of Maine.

John L. Ayres, Salesman, E. I. du Pont de Nemours & Co., Inc., Portland, Ore.

Ronald W. Ballantine, Technical Adviser, S. A. Forest Investments Ltd., Johannesburg, S. A., a 1937 graduate of the University of the Wittwatersrand.

Stanley A. Brazela, Assistant Company Engineer, Doeskin Products, Inc., Mt. Tom, Mass., a 1950 graduate of the University of Delaware.

Donald A. Bertolette, Technician, W. C. Hamilton & Sons, Miquon, Pa.

Robert F. Betts, District Sales Engineer, Link Belt Co., Boston, Mass.

Roe C. Blume, Research Supervisor, E. I. du Pont de Nemours & Co., Inc., Waynesboro, Va., a 1948 graduate of New York University with a Ph.D. degree.

Edgar G. Boyce, Technical Service Representative, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. Attended Oakland College.

Erik Bywall, Mill Manager, Stora Kopparbergs Bergslags AB, Falun, Sweden, a 1928 graduate of the Technical University of Darmstadt.

Alan A. Claflin, Consulting Chemist and Manufacturers' Agent, Boston, Mass., an 1894 graduate of Massachusetts Institute of Technology.

James E. Copenhaver, Chief Chemist, Sonoco Products Co., Hartsville, S. C., a 1920 graduate of Emory and Henry College.

William A. Cotton, Assistant General Manager, Masonite Corp., Ukiah, Calif., a 1923 graduate of the University of Michigan.

John B. Davidson, Research Group Leader, Plaskon Div., Libbey-Owens-Ford Glass Co., Toledo, Ohio, a 1939 graduate of Williams College with a Ph.D. degree from Massachusetts Institute of Technology in 1942.

Raoul deSaint Hilaire, Consulting Engineer, Paris, France. Attended Ecole Francaise de Papeterie at Grenoble.

Germaine Desorbay, Manager, Testing Laboratory, Laboratorie pour le Commerce du Papier, Paris, France. Attended the University of Grenoble.

Donald L. Dowling, District Manager, Roots-Connersville Blower Corp., New York, N. Y., a 1920 graduate of the Massachusetts Institute of Technology.

Robert F. Dressler, Chemist, Riegel Paper Corp., Milford, N. J., a 1950 graduate of the New York State College of Forestry.

Robert D. Ellis, Process Engineer, Orangeburg Mfg. Co., Inc., Orangeburg, N. Y. Attended New York University.

Richard D. Faber, Metallurgist, The International Nickel Co., Inc., New York, N. Y., a 1939 graduate of Lehigh University.

Jakob Falkenberg, Managing Director, Mathiesen-Eidsvold Vaerk, Boen Station, Norway, a 1924 graduate of the Technical University of Norway.

Robert A. Farrell, Product Engineer, Marathon Corp., Menasha, Wis., a 1932 graduate of Michigan College of Mining and Technology.

Richard W. Flores, Chemist, Riegel Paper Corp., Milford, N. J., a 1950 graduate of Lehigh University.

Bernard W. Forshee, Chemist, U. S. Government Printing Office, Washington, D. C. Attended the University of Virginia.

John Frankevicz, Technical Director, Champion International Co., Lawrence, Mass., a 1936 graduate of Harvard University.

J. Horl Freiday, Contract Engineer, Combustion Engineering-Superheater, Inc., New York, N. Y., a 1932 graduate of Lehigh University.

Harry C. Fromong, Cost Engineer, Evans Products Co., Coos Bay, Ore. Attended Oregon State College.

Armand M. Giguere, Plant Engineer, Marinette Paper Co., Inc., Port Edward, N. Y., a 1934 graduate of the University of Maine.

Cary S. Giles, Research Director, Tecnifax Corp., Holyoke, Mass., a 1943 graduate of Harvard University.

John E. Gooddie, Chemist, Canadian Bank Note Co. Ltd., Ottawa, Ont., Canada. Attended the Technical Colleges of Manchester, England, and Glasgow, Scotland.

Earl J. Gosnell, Chief Chemist, The Todd Co., Inc., Rochester, N. Y. Attended George Washington University and Maryland University.

Nels J. Gothard, Chief Chemist, Sinclair Refining Co., Harvey, Ill., a 1914 graduate of the University of Wisconsin.

William D. Hall, Research Director, Folding Paper Box Association of America, Chicago, Ill., a 1921 graduate of Carnegie Institute of Technology.

Sydney A. Hanks, Sales Representative, Monsanto Chemical Co., Everett, Mass., a 1946 graduate of the University of Michigan.

Alan B. Helffrich, Paper Consultant, New York, N. Y., a 1925 graduate of Pennsylvania State College.

Donald A. Hughes, Sales Engineer, R. T. Vanderbilt Co., New York, N. Y., a 1948 graduate of Clarkson College.

Gloria E. Hunter, Graduate Fellow, New York State College of Forestry, Syracuse, N. Y., a 1948 graduate of Bucknell University with an M.S. degree from Syracuse University in 1950.

Arthur H. Hupp, Student, Western Michigan College, Kalamazoo, Mich.

Howard H. Irvin, Chief Chemist, Marbon Corp., Gary, Ind., a 1943 graduate of Rose Polytechnic Institute.

Heishiro Ito, Managing Director, Dainippon Celluloid Co. Ltd., Osaka, Japan, a 1924 graduate of Tokyo Technical College.

Charles Kelley, Jr., Assistant Sales Manager, H. & T. McCluskey & Sons, Inc., New Haven, Conn.

John S. Kirkland, Chief Electrician, Macon Kraft Co., Macon, Ga. Attended Coyne Electrical School.

Ralph Lampo, Head, Research and Adhesive Mfg., Arvey Corp., Jersey City, N. J., a 1927 graduate of the University of Cincinnati.

Richard A. Lloyd, Chemical Engineer, Port Huron Sulphite & Paper Co., Port Huron, Mich., a 1947 graduate of Michigan College of Mining and Technology.

James L. McClellan, Chemist, Crocker-Burbank Co.,

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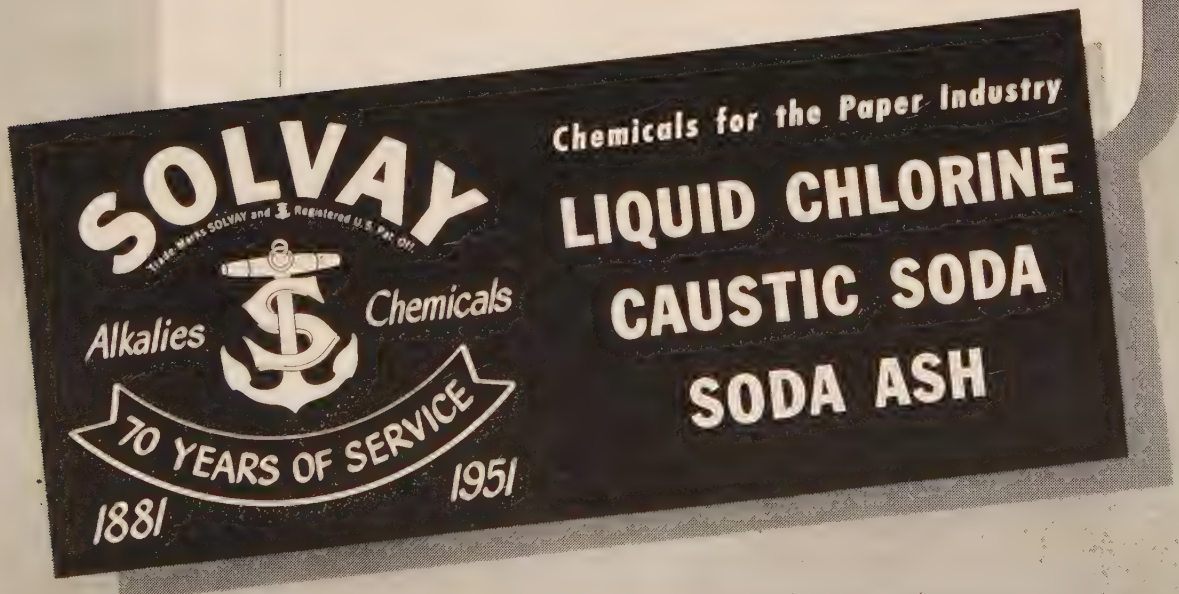

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Fitchburg, Mass., a 1918 graduate of the Massachusetts Institute of Technology.

Nathan C. Martin, Sales Engineer, American Cyanamid Co., New York, N. Y. Attended Brooklyn Polytechnic Institute.

Burt Mendlin, Production Engineer, Cornell Wood Products, Hummel & Downing Div., Milwaukee, Wis., a 1950 graduate of the Massachusetts Institute of Technology.

Horton N. Meyer, Jr., Vice-President and Sales Manager, The Cowles Co., Inc., Cayuga, N. Y. Attended Cornell University and Buffalo University.

Sture G. Olsson, Plant Engineer, The Chesapeake Corp. of Virginia, West Point, Va., a 1942 graduate of the University of Virginia.

Richard C. Peterson, Production Trainee, Riegel Paper Corp., Milford, N. J., a 1950 graduate of Lehigh University.

Edward J. Romatowski, Chemist, Plaskon Div., Libbey-Owens-Ford Glass Co., Toledo, Ohio, a 1947 graduate of Ohio State University.

Arthur Schweidle, President, Vineland Chemical Co., Vineland, N. J., a 1938 graduate of Antioch College.

L. R. Sherlock, Chemist, Fir-Tex Insulating Board Co., St. Helens, Ore., a 1943 graduate of Kansas State College.

John Snoop, Technical Adviser, Innis Speiden & Co., New York, N. Y.

Edward E. Stephenson, Jr., Student, Western Michigan College, Kalamozoo, Mich., a 1949 graduate of Purdue University.

Sam S. Stevens, Consultant to Pulp and Paper Mills, Plattsburg, N. Y. Attended Columbia University.

Eric H. Sundback, Student, New York State College of Forestry, Syracuse, N. Y.

Frank J. Sweeney, Chemist, Stein, Hall & Co., New York, N. Y.

Raymond H. Taylor, Student, New York State College of Forestry, Syracuse, N. Y.

John M. Tinker, Director, Jackson Laboratory, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., a 1918 graduate of the University of Chicago.

George F. Waldhaus, Chief Chemist, Fibreboard Products, Inc., Antioch, Calif., a 1941 graduate of St. Mary's College.

Henry B. Wallace, Jr., Manager of Steam Sales, Foster-Wheeler Corp., New York, N. Y., a 1935 graduate of Drexel Institute of Technology.

William S. Wallace, Librarian, University of Toronto, Toronto, Ont., Canada, a graduate of the University of Toronto and Oxford University.

Claire B. Walworth, Senior Chemist, Plaskon Div., Libbey-Owens-Ford Glass Co., Toledo, Ohio, a 1949 graduate of Michigan State College.

W. Harold Watson, Technical Assistant, Polymer Corp. Ltd., Sarnia, Ont., Canada, a 1929 graduate of the University of Toronto.

Fred J. Wilson, Technical Director, The Martin Cantine Co., Saugerties, N. Y., a 1949 graduate of St. Johns University.

DeWitt A. Worrell, Sales Engineer, General Electric Co., Philadelphia, Pa., a 1936 graduate of the Georgia School of Technology.

TAPPI Notes

Harold R. Alley, formerly with Charles E. King & Co., is now Staff Representative of the Pulp and Paper Section, National Safety Council, Chicago, Ill.

Hector Audino, formerly Industrial Consultant, is now Technical Director, William W. Fitzhugh, Inc., Brooklyn, N. Y.

Forrest W. Brainerd, formerly of the Scott Paper Co., is now Plant Manager, Falls Paper & Power Co. (a Scott Subsidiary), Aconto Falls, Wis.

C. E. Carpenter has retired as Vice-President of the Ohio Boxboard Co. but continues as a Director. He is now President of Oco Water Systems, Inc., Fort Miller, N. Y.

Sidney M. Collier, formerly of the Puget Sound Pulp & Timber Co., is now Superintendent of the H. R. MacMillan Export Co. Ltd., Nanaimo, B. C.

Harold V. Dearden, formerly of Westbury Engineering Co., is now Assistant Managing Director of Millspaugh Ltd., Sheffield, England.

J. Marshall De Cew, formerly of the Armstrong Cork Co., is now Sales Engineer for Oliver United Filters, Inc., New York, N. Y.

E. Ekholm, is now Vice-President in Charge of Operation, Puget Sound Pulp & Timber Co., Bellingham, Wash.

Robert S. Ellis, formerly of S. D. Warren Co., is now a salesman for the Raw Materials Co., Boston, Mass.

Henry W. Fales, formerly of the Wood Flong Corp., is now Assistant General Manager of the St. Croix Paper Co., Woodland, Me.

John N. Franklin, is now Technical Director of Bowater's Newfoundland Pulp and Paper Mills, Ltd., Corner Brook, Nfld.

George D. Fronmuller, formerly of the Scott Paper Co., is now Research Director for the Commonwealth Color & Chemical Co. New York, N. Y.

Norman B. Gibbs, Consulting Engineer, has moved from New York City to West Bay Street, Perry, Fla.

William G. Gray, Jr., is now Assistant Manager, St. Mary's Kraft Corp., St. Mary's Ga.

Richard J. Grimm of the St. Regis Paper Co. has been transferred from Deferiet, N. Y., to the Kalamazoo, Mich., mill where he is Coating Chemist.

W. O. Hisey, formerly of the South African Pulp & Paper Industries, Ltd., has joined the Sandy Hill Iron & Brass Works organization at Hudson Falls, N. Y.

Ralph G. Johnstone, formerly of the Brompton Pulp & Paper Co., is now Vice-President and General Manager of St. Raymond Paper Ltd., St. Raymone, P. Q.

Franklin L. Jones is now Technical Director of the St. Joe Paper Co., Port St. Joe, Fla.

Arnold Kaplan is now Head of the Technical Laboratory, Frank M. Sayford Co., Brooklyn, N. Y.

E. G. Kominek of Infilco, Inc., has been transferred from Chicago, Ill., to Tucson, Ariz.

Gerard Larocque is now Administrative Assistant to the Business Manager of the News Syndicate Co., New York, N. Y.

Robert W. McAloan, formerly of the Union Mills Paper Mfg. Co., is now Research Chemist for the Panelyte Division, St. Regis Paper Co., Trenton, N. J.

John J. McDonald, is now Pulp Sales Manager for the Brown Co., New York, N. Y.

Frank Makara, Patent Attorney, is now located at 1484 Watson Ave., Bronx 59, N. Y.

Darrell M. Martin, formerly of the Institute of Paper Chemistry, is now Chemist for the Cornell Wood Products Co., Hummel & Downing Division, Milwaukee, Wis.

Vincent J. Mohan, formerly of E. I. du Pont de Nemours & Co. Inc., is now a Gravure Technician, General Printing Inc. Co., Division, Sun Chemical Corp., North Bergen, N. J.

Ralph T. Nazzaro, formerly Assistant Professor of Forestry Chemistry, New York State College of Forestry, is now Director of Research, Texon, Inc., South Hadley Falls, Mass., and Russell, Mass.

Arno W. Nickerson, has removed his consulting offices from New York City to 34 Cushman Road, White Plains, N . Y.

Newton L. Nourse is now General Sales Manager for the Brown Co. New York, N. Y.

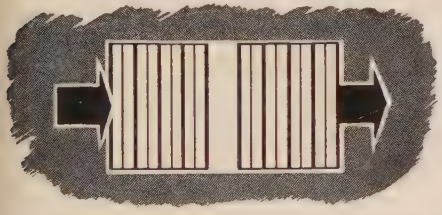
C. P. Olsted is now Manager of Manufacturing, Waxide Paper Co., St. Louis, Mo.

These 10 BIG Features Make Western Precipitation COTTRELLS Outstanding in the Paper Industry

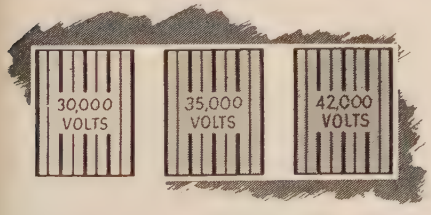
When considering COTTRELL Equipment for salt cake recovery, or any other application in the paper industry, remember this . . . *Western Precipitation Corporation not only pioneered the first commercial application of* COTTRELL *equipment made in any industry, but also pioneered the first application of* COTTRELL *equipment in the paper industry.*

Among the vitally important advantages found in Western Precipitation COTTRELLS, the following are particularly important in paper mill installations . . .

1 **Sustained Year-After-Year Efficiency:** The recovery efficiency of Western Precipitation COTTRELLS does not fall off in service. All parts are of ample design to maintain guaranteed over-all efficiency year-after-year —not for just a single acceptance run.



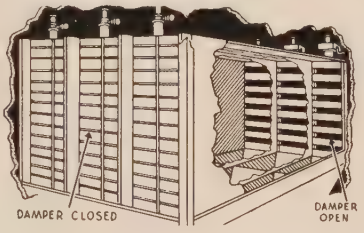
2 **Higher Recovery:** The horizontal flow design of Western Precipitation COTTRELLS eliminates collected material falling countercurrent to incoming gas stream This assures higher recovery, minimum resuspension of recovered material in gas stream.



3 **Maximum Performance:** Horizontal flow of Western Precipitation COTTRELLS permits use of multiple electrical sections so that voltage in each section can be varied to dust loading for maximum recovery without arc-over or electrical breakdowns.

4 **Lower Over-all Cost:** When comparing COTTRELL costs, be sure to compare total *installed* cost, including duct work.

5 **Simpler Maintenance:** Because all interior parts and electrode systems are readily accessible, Western Precipitation COTTRELLS are far easier to maintain and service. Saves "down" time, saves repair costs.



6 **Greater Adaptability:** Horizontal flow design permits use of multi-vane dampers in multiple-unit installations. Thus, one unit can be shut off completely to permit maintenance operations without closing down entire Precipitator. Also, the dampers can be used in slightly-closed position to assure more uniform gas distribution.
On single-unit installations, chain curtains assure uniform distribution of gases. Curtains are easily kept clean by shaker mechanisms provided.

7 **"V"-Shaped Hoppers:** Horizontal design permits use of continuous "V"-shaped hoppers for collecting recovered material. Steeply-sloped walls in this type of hopper prevent build-up or bridging of recovered material.

8 **Space-Saving Compactness:** Not only do their horizontal design permit maximum compactness in Western Precipitation COTTRELLS, but various sections of a unit can be arranged for indoor installation in space above cascade evaporators, thus utilizing space otherwise wasted.

9 **All-Weather Construction:** Western Precipitation COTTRELLS are built for both indoor or outdoor installation, and this organization has had extensive experience with special construction to prevent excessive corrosion in rigorous northern climates.

10 **More Extensive Experience:** Since pioneering the commercial application of COTTRELL Precipitators over 42 years ago, Western Precipitation has consistently led in developing one unique advancement after another. Such features as 4-Point Electrode Suspension that eliminates misalignment of electrodes and reduction in recovery efficiencies . . . Unusually Rugged Rapper Design that assures proper cleaning of electrodes . . . Extensive Experience with all types of electrode designs . . . and many other advantages assure you the ultimate in COTTRELL design and efficiency when you bring your recovery problems to Western Precipitation engineers.

Without obligation our nearest representative will gladly make Western Precipitation COTTRELL *experience available to you for solving your particular recovery problem. Why not contact him today?*

IMPORTANT! In addition to COTTRELL *Electrical* Recovery equipment, Western Precipitation Corporation also designs and installs the well-known MULTICLONE *Mechanical* Collectors for hogged-fuel fired boilers. These units are unusually compact, highly efficient and can be readily fitted into existing plants at minimum installation costs. *Write for details!*

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PRECIPITATION CO. OF CANADA, LTD., DOMINION SQ. BLDG., MONTREAL

R. Paradis, formerly of the Brown Corp., is now Resident Manager, Howe Sound Pulp Co., Port Mellon, B. C.

Wallace E. Parsons is now President of the Keyes Fibre Co., Waterville, Me.

Charles L. Peckham, formerly Technical Assistant of the Institute of Paper Chemistry is now Technical Engineer, Container Corp. of America, Wabash, Ind.

Robert T. Powers, District Engineer for the National Aluminate Corp., has moved from Grand Rapids, Mich., to Kalamazoo, Mich.

Thomas L. Reiling, formerly of the Brown Co., is now Senior Salesman for Emery Industries, Springfield, Mass.

Edgar L. Russell, formerly of R. R. Donnelly & Sons, is now Quality Control Supervisor for W. H. Hutchinson & Son, Inc., Chicago, Ill.

E. Schoenberg, formerly of F. W. Heilgus & Co. Ltd., Calcutta, India, is now in charge of the Straw Cellulose Research Station, Algemene Kunstizijde Unie, N. V., Arnhem, Netherlands.

Joseph W. Shimp, formerly of the Scott Paper Co., is now Production Manager, Marinette Paper Co., Marinette, Wis.

Frederick A. Soderberg is now Manager Industrial Division, General Dyestuff Corp., New York, N. Y.

Lt. Paul I. Taylor is on military leave from the Union Bag & Paper Corp., Savannah, Ga., and is now with the 117th Aircraft Control and Warning Squadron, Sewart Air Force Base, Smyrna, Tenn.

Fletcher P. Thoront, Jr., is now President and Treasurer of W. E. Greene, Corp., Woolworth Bldg., New York 7, N. Y.

Jens Thue is now Manager of the Canadian International Paper Co., Hawkesbury, Ont.

Alvin R. Wilson, formerly of the Newark Paraffine & Parchment Paper Co., is now with Wynmoor Mfg. Corp., Verona, N. J.

John O. Younger, formerly of the Empire Box Co., is now Packaging Technologist, Testing Division, Container Laboratories, Quartermaster Food and Container Institute, Chicago, Ill.

Industry Notes

Interim increases in freight rates and charges were authorized by the Interstate Commerce Commission on March 12, 1951, effective April 4, 1951. All basic freight rates and charges (except on coal) may be increased: 4% within Eastern Territory; 2% within Southern Territory; 2% within Western Territory; and 2% Interterritorily between the three territories. Basic rates are those that were in effect prior to April 4. For anthracite and bituminous coal and coke an increase of 2%, subject to 6 cents per net ton or 7 cents per gross ton.

* * *

The Office of Price Stabilization has officially announced the following appointments to the Forest Products Division: Director, John D. Mylrea; Acting Assistant Director, Walter J. Damtoft; Acting Chief, Lumber and Wood, Norman O. Cruver; and Acting Chief, Pulp, Paper and Paperboard, Rufus I. Worrell.

* * *

A controlled materials plan will go into effect on July 1, according to the NPA, and will replace the priority system of DO ratings, which is proving inadequate. Copies of the regulations and procedural forms are available through the Department of Commerce, Washington, D. C., and at field offices.

* * *

Under the NPA amendment to Order M-36, paper manufacturers were order to increase their reserve of book and fine papers from the former 10 to 15%. These fine papers include types used for printing maps and similar materials. Special industrial paper reserves are to be increased from 5 to 15%, and crepe wadding for packing reserve from 10 to 25%. The required reserve of printing converting papers, paper machine coated, used widely by commercial printers, was cut from 10 to 5%. The required reserve for newspring and groundwood papers remains unchanged at 5%.

NPA Order M-53 provides rules for placing, acceptance, and scheduling rated orders for cotton duct. Manufacturers of cotton duck are required to set aside 80% of their scheduled quarterly production for DO rated orders. In this connection it is understood that the looms of manufacturers of cotton drier canvas are used for the purpose only and are not suitable for or easily converted to the production of other grades. DO-97 ratings are available to manufacturers of pulp, paper, and board under Regulation 4.

* * *

More than $1,133,000 were spent by pulp and paper mills during 1950 to reduce all types of paper industry pollution of Wisconsin streams, according to N. L. Malcove, Acting Chairman of the Advisory Committee on Waste Disposal of the Wisconsin Pulp and Paper Industry and Technical Superintendent of the Northern Paper Mills, Green Bay, Wis. The individual mills spent more than $315,000 on actual research, including their contributions to organizations that conduct joint research programs into Wisconsin problems. The mills spent more than $818,000 on equipment that reduces pollution, including screens, savealls, and other permanent installations.

Expenditures during 1951 are likely to make greater totals. Three mills on the Fox River have agreed to build sulphite liquor disposal plants at a total cost of $4,000,000, and construction of some of these plants is already underway.

* * *

A bulletin (Occasional Paper 116) on the management of bottomland hardwoods, the first on the subject, has been issued by the Southern Forest Experiment Station, 1008 Federal Office Building, New Orleans 12, La. Over 30 million acres, or about one fifth of the South's total forest area, is in bottomland types. The greatest concentration is in the Mississippi delta, but nearly every southern state has substantial acreages.

* * *

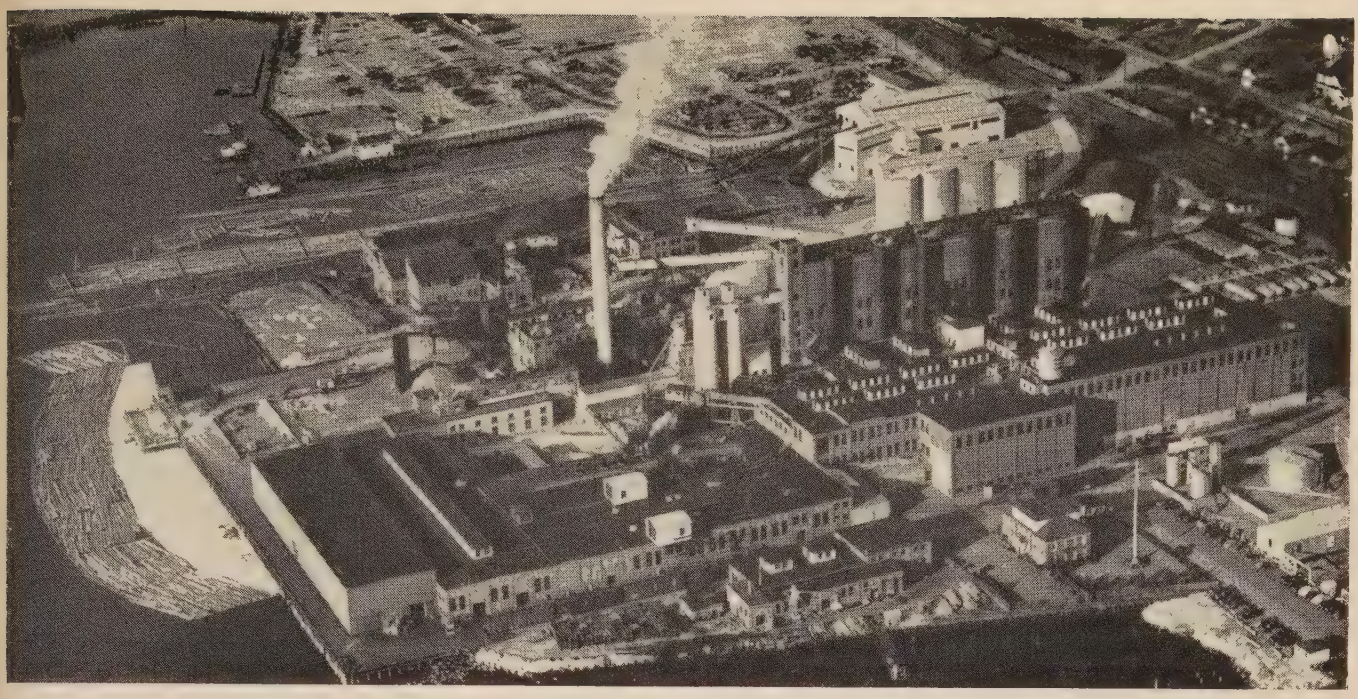
The Northeast Forest Experiment Station, Upper Darby, Pa., has issued Station Paper No. 38 on "Form-Class Volume Tables for Estimating Board-Foot Content of Northern Conifers."

* * *

An intensive two-week summer course in "Paper—Its Properties and Uses," sponsored by the Boston Paper Trade Association, will be given at Lowell Textile Institute, Lowell, Mass., June 11–22, 1951. A similar course, attended by 19 men, was given last year. The instructors will be Geoffrey Broughton and W. B. Wheelwright. Tuition is $150, including books, meals, and dormitory accommodations. Applications should be sent to Dr. Broughton.

* * *

Prominent members of the paper industry will play a prominent part in the forthcoming 500 million dollar bond issue to be floated in the United States by the State of Israel. Among those in the industry who have become affiliated with the drive are D. S. Gottesman, Central Material Co., New York, N. Y.; Meyer Jaffe, J. & J. Corrugated Box Corp., Fall River, Mass.; Milton Kahn, Kahn Paper Co. Boston, Mass.; Joseph M. Mazer, Hudson Pulp & Paper Co., New York, N. Y.; Harry Preston, Golden Fleece Tissue Mills,



SOUNDVIEW PULP COMPANY

EVERETT, WASHINGTON

MANUFACTURERS AND DISTRIBUTORS OF

HIGH GRADE
BLEACHED
SULPHITE PULPS

Inc., New York, N. Y.; Harold Shilling, U. S. Paper Supply Co., Chicago, Ill.; and J. Sincoff, Jacob Sincoff, Inc., New York, N. Y.

* * *

A major expansion program for the Savannah plant of the Union Bag & Paper Corp. that will include the addition of a new paper machine and the installation of equipment for the manufacture of semichemical pulp through the use of hardwood was announced recently by Alexander Calder, President. The addition of the semichemical pulping process to the mill's highly integrated manufacturing and converting operations and the installation of the sixth paper machine will increase the plant's daily production of kraft paper and paperboard by about 400 tons. Work on the several projects are under way and is expected to be completed during the first half of 1953. Morton C. Tuttle Co. of Boston will be the general contractors. The engineering will be under the direction of Robert T. Inman, Chief Engineer of Union Bag. The six machines in the Savannah mill are six of the nine largest machines in the world.

* * *

Speaking at the A.P.P.A. annual meeting on the effect of paper imports, D. K. Brown, President of the Neenah Paper Co., pointed out that in the 10 years preceding World War II, no other industry came near equaling paper and pulp in the creation of dollar exchange. During that period the net-dollar exchange created by the absorption of imported pulp and paper was $1,635,000,000. Total imports were $1,965,000,000 and exports were only about $330,000,000. The United States paper market in 1948 alone absorbed imports of pulpwood, wood pulp, papermaking materials and paper amounting to over $750,000,000. These imports were the largest for any single industry or commodity in the United States.

* * *

George M. Hunt, after 40 years of service with the U. S. Forest Service, has retired as Director of the Forest Products Laboratory at Madison, Wis. He has been succeeded by J. Alfred Hall, formerly Director of the Pacific Northwest Forest and Range Experiment Station, Portland, Ore. Mr. Hunt is noted for his studies in wood preservation, painting, glueing, and fireproofing.

* * *

Burnham B. Holmes, formerly of the Inland Container Co., has been appointed General Manager of the new and independent Box and Paperboard Division of Ball Brothers Co., Inc., Muncie, Ind.

* * *

Sandwell & Co. Ltd. has removed its offices in Vancouver, B. C., to 1500 West Georgia Street.

* * *

In order to insure maximum speed and operating efficiency in the New York area, manufacturers, dealers, and bona fide manufacturers' agents desiring to be listed as potential sources of supply for items purchased by the Navy should be careful to address all communications to the Officer-In-Charge, Navy Purchasing Office, 111 East 16th Street, New York 3, N. Y.

* * *

Changes of major economic importance to this area went into effect at the Luke mill of West Virginia Pulp and Paper Co. in April. A new recovery plant, housed in an eight-story steel and tile building at the west end of the mill yard, began operations, enabling the mill to switch over from an old soda process to the modern sulphate method of making pulp.

This change means that the mill, which is the main economic support of the community, can now take better advantage of the supply of hardwoods available in this region and begin to fortify its position in the highly competitive field of publication papers.

The key to the change-over is a large new smelter unit, especially designed to recover the special chemicals used to cook wood chips by the sulphate method. This installation, which took over a year to build, includes a 250-ton recovery furnace, capable of handling more than 600,000 gallons of spent liquor daily, combined with a boiler unit which will produce about 100,000 pounds of high-pressure steam per hour.

In reviewing the background of the change, plant officials explained that the kinds of paper made at any integrated pulp and paper mill depend largely on the kinds of wood within economic reach. Strong papers for packaging and similar uses are made most frequently where ample stands of pine and other conifers grow nearby. Where the forest is mostly hardwood, as at Luke, pulp more readily goes into papers for magazines and other printing purposes. With the soda process, which it helped pioneer, the Luke mill for years held a top position in this field. The advent of the sulphate method, however, made it difficult to keep up with newer mills producing stronger and relatively better hardwood pulp, at lower costs, by the new process.

There were a number of major technical and economic problems to be overcome before the new process could be introduced at Luke. Most of these have now been solved, or at least reduced to manageable proportions, and, with the new pulp layout and other improvements completed or planned, the company expects the competitive position of the Luke mill to improve steadily. The mill, it was pointed out, enjoys an excellent location with respect to wood supply and transportation to the market.

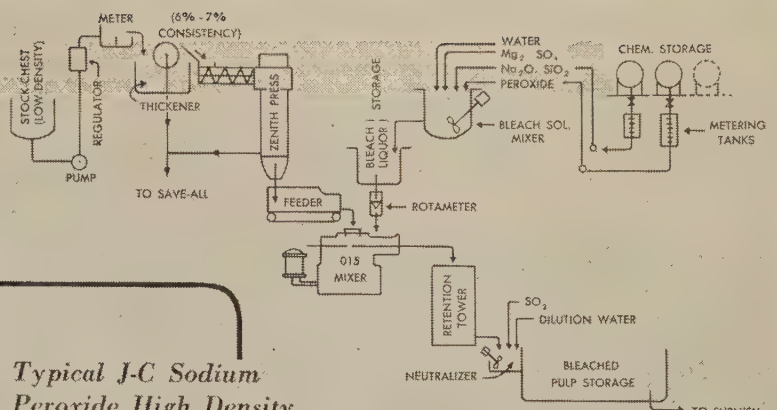
The building which houses the smelter unit is 50 $\times$ 100 feet, towers 104 feet high, and is topped by a 67-foot stack, $7^1/_2$ feet in diameter, clad in stainless steel. The stack is equipped with an electrostatic precipitator, which collects chemical fines carried upward by flue gases. Six hundred tons of steel, 2500 tons of concrete, and more than 91,000 building tiles went into construction of the building.

In the first step of the new recovery process, spent liquor from the digesters, where the wood is cooked, is boiled under vacuum in a battery of multiple effect evaporators, reducing it to the consistency of molasses. This soup then is piped to the recovery unit where a cascade evaporator, using heat provided by waste gases from the boiler, concentrates it further. To this concentration is added the chemical fines collected by the precipitator, plus salt cake, to change the chemicals back into their original form and thus complete the recovery cycle.

The big smelter replaces seven costly rotary incinerators and thirteen leachers used in the past to recover spent liquor from the soda process. The rest of the pulp manufacturing layout at the Luke mill remains about the same as in the past, except that one new digester of 3520-cubic foot capacity has been added to supplement the five digesters formerly in operation. The sixth digester may ultimately allow the plant to increase its pulp production from 170 to about 200 tons per day, bringing the plant's paper and pulp production in closer balance.

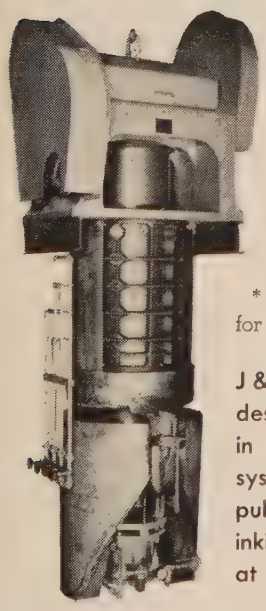
The new recovery unit should result in considerable improvement in the condition of the Potomac River, from which the plant draws its water supply and into which it returns waste water. It was pointed out that the capacity of the old recovery line was not sufficient to handle all the liquor required for the 170 tons of pulp produced daily at the mill, with the result that some of the weaker wastes escaped into the river. The new smelter not only is more efficient than the old equipment, recovering nearly all the spent liquor for reuse, but is designed for a greater capacity. Engineering estimates indicate that the new equipment will provide consider-

Jackson and Church — HIGH DENSITY SYSTEM



Typical J-C Sodium Peroxide High Density Bleaching System

USES *NO MORE* PEROXIDE TO BLEACH *HIGHER* TONNAGE TO *SAME* BRIGHTNESS or *SAME* TONNAGE TO *HIGHER* BRIGHTNESS



* Patents applied for J & C copyright

J & C Zenith Press designed for use in high density systems, and in pulp washing, de-inking and storage at high density.

For engineering assistance and actual mill performance data, write Dept. D

The J&C High Density System makes possible bleach consumption savings up to 25%.

HERE ARE ADDITIONAL ADVANTAGES:

High density—40% or higher
Continuous operation
Fully automatic operation
Selective pressure control
Product of uniform consistency
Moderate first cost
Extremely rugged construction
Available in corrosion resistant alloys
Low power requirement
Minimum floor space
Aids good housekeeping

JACKSON & CHURCH COMPANY · SAGINAW, MICHIGAN

ably more capacity than that needed to handle liquor from the 170 tons now produced and will give the plant leeway for more tonnage if and when further expansion is indicated.

The new recovery unit also is expected to reduce the amount of dirt and smoke usually associated with such operations. The precipitator unit on the stack will recover daily about 15 tons of fly ash, greatly reducing the quantity of fumes and dust previously released into the atmosphere by the old rotary furnaces.

In addition to the production and recovery advantages of the smelter unit, plant officials explained that the new equipment adds considerably to the steam-producing capacity of the plant. Steam is used in great volume for cooking pulp, drying paper, concentrating spent liquor, heating, and scores of other purposes. The new boiler unit will produce at great economy about 100,000 pounds of steam per hour, at 600-pound pressure, or about 20% of the steam used at the mill. This is considerably more than the capacity of the old rotary furnaces. Almost 12 miles of $3^1/_4$-inch steel boiler tubing is built in the new boiler.

Although the smelter was the major project of the past year, another improvement of importance was the consolidation of the paper sheeting and trimming operations in the building formerly occupied by the Old Coating Mill. This new finishing department gives the plant a line of ten cutters and eight trimmers all located in the same building.

Another project of major economic significance is contemplated in the near future, the rebuilding of No. 6 and 7 paper machines, the largest of seven operated at Luke. This project will allow paper to be manufactured at around 1200 feet per minute, compared to present speeds of about 550 feet per minute. These two machines were converted a few years ago to the manufacture of machine coated book paper, but at present lack the speed necessary to make this grade profitably.

The work will include the installation of longer fourdrinier sections, suction presses, breaker stacks, additional driers, and larger drives on the machines themselves. Auxiliary equipment serving the machines will have to be expanded, too. This means more screening capacity, new and larger pulp refining equipment, a larger saveall system, a new ventilating system, new pumps, and pipelines.

* * *

The Freeport Sulphur Co. will obtain sulphur from a new dome near Houma, La. This dome is under marsh water. Equipment will be transported to the site by barge. The molten sulphur will be barged to Port Arthur for storage. After the dome is depleted, equipment will move on to other marshy domes that the company is exploring.

Speaking before the Am. Inst. Mining & Metallurgical Engineers recently, Langford M. Williams, Jr., President of the Freeport Sulphur Co., pointed out that if and when the price of sulphur rises from the present $22 per ton to $30, production from pyrites (46% iron and 53.3%) sulphur can compete.

From the standpoint of cost of production brimstone is the cheapest, followed by pyrites, smelter gas, gypsum, and coal.

* * *

The Texas Gulf Sulphur Co.'s first sulphur recovery plant went into operation in April, 1950, at Worland, Wyo., producing over 300 long tons of sulphur per day. The method of recovering sulphur from sour natural gas, so called because of its high hydrogen sulphide and carbon dioxide content, marks the first large-scale production of sulphur by Texas Gulf, other than from the salt domes of Texas. The main units of this plant consist of a monoethanolamine absorption unit for removing hydrogen sulphide from the sour gas, and a unit for converting hydrogen sulphide to sulphur.

The unit for converting hydrogen sulphide to sulphur was designed by Foster Wheeler and includes waste heat boilers and waste heat economizers. The hydrogen sulphide gas obtained from the monoethanolamine absorption unit is charged to the reactor furnace of the sulphur recovery plant. Controlled combustion for subsequent catalytic conversion results in the production of elemental sulphur. The design capacity of the plant is 400 long tons per 48 hours. The plant is owned by the Pure Oil Co.

* * *

Shortages of soda ash, chlorine and liquid caustic soda can be attributed in part, at least, to the inadequate number of box cars and tank cars.

* * *

The Dorr Co., Barry Place, Stamford, Conn., has just issued a 32-page bulletin describing the Dorrco Hydro-Treater. This unit of equipment is used for softening, color, and turbidity removal from water supplies.

The Dorr Co. has also announced its Fluo Solids System for roasting pyrites for the production of sulphur dioxide.

* * *

Following is the organization of the Forest Products Division of the Office of Price Stabilization:

Director—John D. Mylrea.
Co-Director—W. J. Daintaft.
Pulp Paper and Board Section—Rufus Worrell, Director, Mike Walsh, Assistant, and Quincy Adams, Economist.
Pulpwood Subsection—C. O. Brown.
Wood Pulp Subsection—S. Posen.
Paper Subsection—Not assigned.
Board Subsection—N. M. Brisbois.
Wash Paper Subsection—J. T. Flannery.

* * *

Following in the organization of the Pulp, Paper and Board Division of the National Production Authority:

Director—G. J. Ticoulat.
Assistant—W. L. Neubrech.
International Aspects—Paul S. Fiske.
Machinery and Equipment—Wm. J. Maney and John H. O'Connell.
Certificates of Necessity—A. M. Howe.
Programs and Stabilization—W. H. Pederson.
Miscellaneous—Walker J. Myers.
Fine Paper—John Cryan.
Coarse Paper—T. H. Mullen.
Tissue Paper—James Maloney.
M-36—Harold Wright and John Franzen.
Paperboard—O. K. Krogfoss.
Container Board—Jack Moore.
Box Board—Charles Mayer.
Pulpwood, Wood Pulp and Wash Paper—M. H. Collett.
Waste Paper—Wm. Edwards.

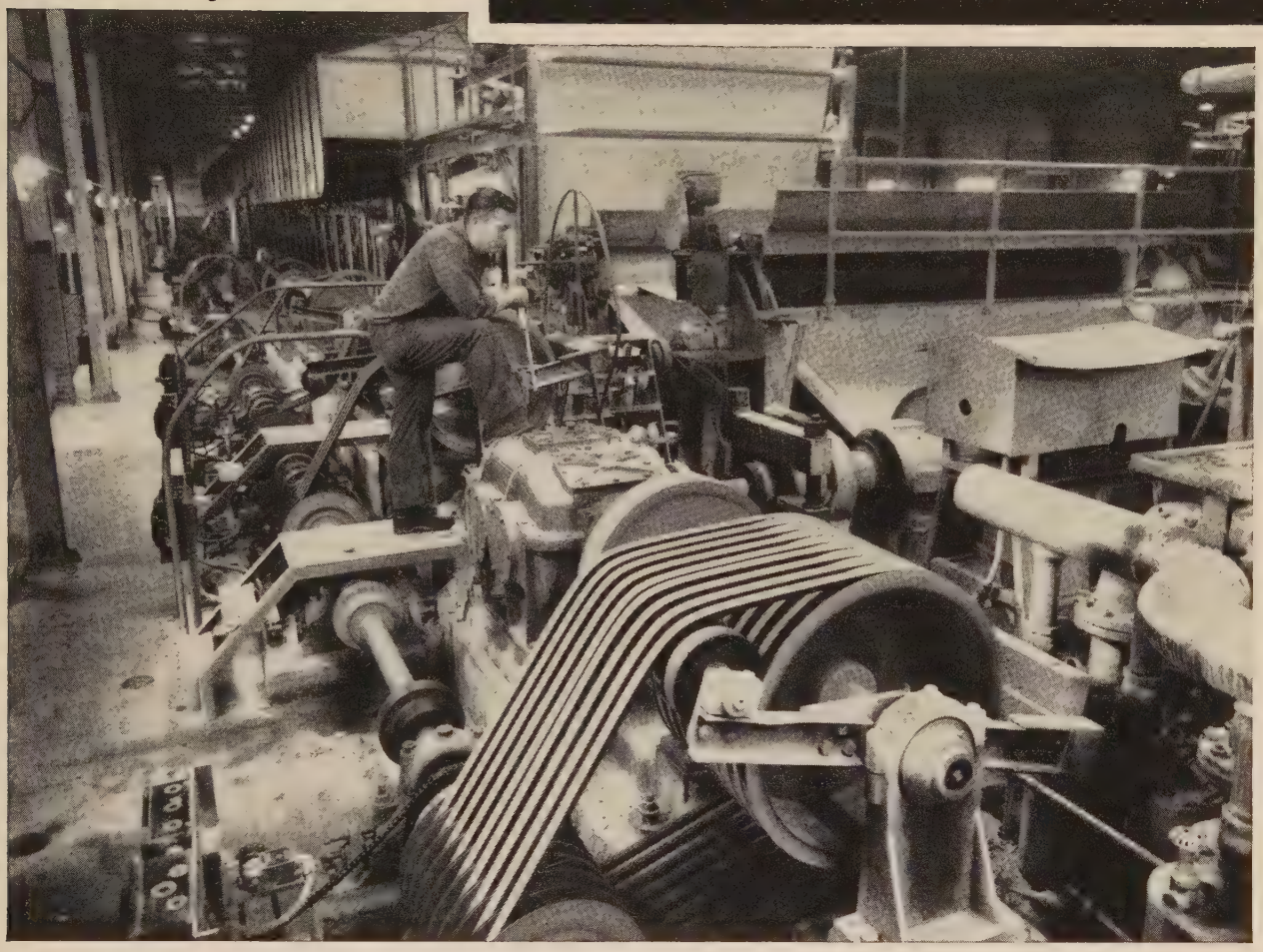
* * *

W. O. Hisey joined the organization of the Sandy Hill Iron and Brass Works on May 15. Since 1944, Mr. Hisey has been a consultant and development engineer for the Union Corp., Ltd., operating the South African Pulp and Paper Industries Ltd. Here he converted a mill from the Pomilio process, using straw, to a modern bleached sulphate mill, using local timber. Prior to going to South Africa, Dr. Hisey worked for the Oregon Pulp and Paper Co., Oxford Paper Co., Celotex Co., and P. H. Glatfelter Co. In 1934 he joined the faculty of the New York State College of Forestry, where he remained until 1944. Mr. Hisey has been active in TAPPI for several years.

W. O. Hisey

Solving the Exacting Problems of 1951

Sandy Hill Selective Drive



More and more installations of Sandy Hill Selective Drives are drawing the enthusiastic praise of mill men looking for the perfect answer to an unvarying draw between sections.

Illustrated here is an installation in one of the largest midwestern mills producing fine paper. This and many other installations in all parts of the world are proving the efficient operation, economy and safety of these Drives year in and year out. Embodying the most modern ideas in power transmission, the Sandy Hill Selective Drive provides a fineness of draw regulation and exact draw maintenance, combined with simplicity, power saving and low first cost, to a degree hitherto unknown. These advantages result from the effective use of variable pitch V belt sheaves. It gives more than 3 times the draw range of the cone pulley and flat belt.

Compared with any other type drive it has a minimum of moving parts and parts subject to failure. Installation of the Selective Drive eliminates the need of a basement or steel superstructure for a line shaft. The line shaft is installed on the floor on low piers, not over eighteen inches high.

Sandy Hill's new brochure on Pulp and Paper Making Machinery is available on request.

Sandy Hill Iron & Brass Works

Hudson Falls, N. Y.

Machinists and Founders Specializing in Paper and Pulp Mill Machinery

Manufacturers of
Adjustable Cylinder Vats
Cylinder Paper Machines
Pulp Grinders
Dandy Roll Drives

Pulpers or Kneaders, Voith
Thickeners
Quick Opening Gate Valves
Bertrams Flow Distributors
Bertrams Shakes

Neilson Slice
Feltless Wet Machines
"Selective" and Corner Drives
Fourdrinier Paper Machines
"Packer" Screens

Castings
Bleaching Equipment
Scofield Felt Conditioners
Cleveland Type Bearings
Shaker Screens

The Brown Co., Berlin, N. H., has announced the following promotions:

Newton L. Nourse, has been appointed to the new position of General Sales Manager. Mr. Nourse joined the company in 1920, after graduating from Colby College. In 1933 he became Manager of the Pulp Sales Division. He developed Salka-Floc from a small cellulose specialty to a major product of the Brown Co. and now consumed widespread by heavy chemical industries.

N. L. Nourse

J. J. McDonald

John J. McDonald succeeded Mr. Nourse as Pulp Sales Manager. Mr. McDonald joined the Brown Co.'s Research Department in 1927, following his graduation from the University of New Hampshire. During the war he was with the U. S. Chemical Warfare Service at Edgewood Arsenal as a Major. In 1945, he returned to the Pulp Sales Division. Both Messrs. Nourse and McDonald are members of TAPPI.

* * *

Shutt Process Equipment Co. has been appointed agent for the Atlas Mineral Products Co. for chemically resistant materials of construction in the St. Louis territory.

* * *

Thonet C. Dauphine has been appointed Manager of Sales Development for the Hooker Electrochemical Co., Niagara Falls, N. Y. Mr. Dauphine, formerly a chemical engineering instructor at the Massachusetts Institute of Technology, was with the Aronite Chemical Co. since 1946.

* * *

The Lindsay Wire Weaving Co., Cleveland, Ohio, has added 20,000 sq. ft. of manufacturing space by acquiring the former plant of the East Shore Machine Products Co. New looms and new wire cloth finishing equipment will be installed.

* * *

The Warren Steam Pump Co. has announced that it will be represented in Louisiana, Mississippi, and Alabama by the Betz Engineering Sales Co. 1225 Magazine Street, New Orleans, La.

* * *

The American Cyanamid Co., 30 Rockefeller Plaza, New York 20, N. Y., has issued a Technical Bulletin No. 21 A on Azite 900 Liquifier. Azite is used for controlling the viscosity of colloidal solutions of starches and proteins.

* * *

A new line of self-adhesive safety signs has been developed by the W. H. Brady Co. These are printed on cotton duck which has a self-adhesive backing. Each sign is coated with silicone plastic to protect it from dirt and weather. Over 550 different signs are available which conform to ASA Standard Z 35.1-1941 for Industrial Accident Prevention Signs. Further information can be obtained from W. H. Schneider, W. H. Brady Co., Dept. 483, Chippewa Falls, Wis.

* * *

William E. Greene has been elected Chairman of the Board of W. E. Greene Corp., New York, N. Y. Other officers elected were F. D. Thornton, Jr., President and Treasurer; E. S. Greene, Vice-President; C. M. Schermerhorn, Vice-President; and R. P. Arnold, Secretary.

* * *

The Brown Instruments Division, Minneapolis-Honeywell Regulator Co. Station 40, Wayne & Wairdrum Aves., Philadelphia 44, Pa., has issued two instrumentation data sheets. No. 2.9-14 a "Engineered Instrumentation Provides Increased Chemical Recovery" and No. 2.9–22 a "Brown Stock Washer Control System Features Flexibility."

* * *

C. A. deVyver has been appointed Manager of Insulations of the Johns-Manville Corp. Duane D. Crews was appointed Manager of Construction of the Industrial Products Division. William R. Wilkinson has been appointed Vice-President for Sales and Kenneth W. Huffine, Vice-President for Production. Work has begun on the site for a new large research building at Manville, N. J.

* * *

Analytical Measurements, Inc., Chatham, N. J., is offering a new pocket-size pH meter for on-the-spot pH determinations. The total weight is 3 pounds. Supports and beakers are eliminated by combining the calomel and glass electrodes with the sample holder, in a single polyethylene probe unit.

* * *

P. H. Hagen has joined Raybestos-Manhattan, Inc., to handle the sales of mechanical rubber products and packings. He will be located at 2221 Fourth Ave., South Seattle, Wash.

* * *

The Blaw-Knox Co. will erect a new chlorine plant for the Mathieson Chemical Co. at McIntosh, Ala., near Mobile. The salt will come from the McIntosh Salt dome.

* * *

Shartle Bros. Machine Co. has issued two interesting bulletins: No. 12-S B describing the Duotrol for Jordans and refiners, and a 16-page Lubrication Guide prepared in collaboration with the Socony-Vacuum Oil Co. for machinery used in pulp and paper mills.

* * *

The Holyoke Machine Co., Holyoke, Mass., wishes to clarify the fact that it is now, and has been since 1880, the sole manufacturer of "Holyoke" paper, cotton, and combination calender rolls for the paper and textile industries. The company, which was found in 1863, is likewise the sole manufacturer of "Holyoke" and "Norwood" water filtration equipment for industrial applications.

* * *

The Babcock & Wilcox Co., 1 Madison Ave., New York 10, N. Y., has issued two bulletins, Nos. 12 F and 19, dealing with stainless tubings and high-temperature, high-pressure tubing steels.

* * *

Hercules Powder Co., Wilmington, Del., has issued a new technical booklet on Resin for Adhesives. This deals with resins' contributions to film cohesion, surface tack, bond strength, and other properties of adhesives.

* * *

Keyes Fibre Sales Corp., 420 Lexington Ave., New York

An Expert can do the Job Better!

THAT'S WHY EXPERTS of Brown Company's Technical Service Division have been helping manufacturers select the right fibre for specification paper for more than a half century.

With Brown Company's vast resources and wood fibre and research experience backing them up, Brown's paper experts are prepared to work in a great range of fields. Their special skills are yours for the asking.

Has the problem of choosing the right fibre and the best process for a new type of paper got you puzzled? Then why not let Brown Company help you? We will welcome the opportunity.

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SULPHUR

Many users of Sulphur are finding that Sulphur Dioxide can be effectively and economically substituted for Sulphur. Many industries have made this conversion and the results have been most satisfactory. Perhaps Sulphur Dioxide can be just as effectively adapted to your operation. At no obligation to you, one of our representatives would be glad to consult with you.

SULPHUR-DIOXIDE
HIGHEST QUALITY
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Write, wire or phone the Tennessee Corporation, Grant Building, Atlanta, Georgia.

TENNESSEE TC CORPORATION
619 Grant Building, Atlanta, Ga.

17, N. Y., has issued a new catalog on Keyes Molded Products. This gives complete descriptions, specifications, and blueprints of the sixteen product lines manufactured by Keyes. Copies are available to jobbers, chain headquarters, and other types of wholesalers or large user outlets.

* * *

Westinghouse Electric Corp. has issued two useful bulletins: "A Planning Guide for Industrial Air Conditioning" (Booklet B-5160), obtainable from the Stuttevart Division, 200 Readville Street, Hyde Park, Boston 36, Mass.; and a leaflet (SA-6691) that describes the Precipitation, from the same address.

H. N. Mills, Jr., of Westinghouse, speaking at St. Petersburg, Fla., pointed out the growing shortage of engineers. During the past 2 years 50,000 engineering school graduates have been assimilated by industry. In 1951 there will be 32,500 graduates. In 1952 it will be 25,000; by 1953, 20,000; and by 1954, a maximum of 17,000. This adds up to a total shortage of 105,000. Engineers should devote time at the local level to encourage high-school students to enter engineerng schools. Company executives should examine their organizations to see if any trained engineers are doing work that can be assigned to supporting personnel.

* * *

Experiments are being conducted in the G.E. Research Laboratory in collaboration with the State College of Washington to show that irradiation with high-voltage electrons, or cathode rays of sawdust, makes part of it digestible by organisms in the cow's stomach. According to W. Dexter Bellamy of the G. E. Division of Biological Effects, a cow is able to utilize pure cellulose (such as cotton) as a food. Cellulose in combination with liquids is indigestible. The cathode rays make the cellulose available. Bacterial action in the rumen, the first of the cow's four stomachs, is able to convert the cellulose into several other compounds, such as acitic, propionic, and butyric acids. These are generally known as volatile acids and can be absorbed in the animal's intestines.

Basswood was used for the experiments, both in the form of sawdust and small wafers. It was irradiated, using a modification of the million-volt x-ray unit developed for medical and industrial use as a source for electrons.

Ordinarily the stream of electrons, accelerated to million-volt energy in a series of steps, hits a tungsten target at the end of the tube, generating a beam of x-rays. When used for cathode rays, a thin aluminum window replaced the target and the electrons themselves emerge. Various materials may then be placed in the beam to study the effects.

After irradiation, the basswood samples were sent to R. H. Hungate, Professor of bacteriology at Washington State College. Since the tests could not be made with enough precision on live cows, the work was done in test tubes, using cultures of bacteria from a cow's rumen. Tubes containing the irradiated sawdust and the bacteria were kept from 1 to 2 days at a temperature of 100°F. This is the cow's bodily temperature, a little higher than the human.

Following the test tube digestion, steam was bubbled through the samples, causing the volatile acids to be evaporated. The vapors were then condensed back to liquid, which was added to caustic soda solution of known strength. By determining how far the volatile acids neutralized the caustic their amount could be measured.

At the intensity of radiation employed, exposures of less than a minute produced no great effect. The maximum was obtained with an exposure of about 12 minutes. Then the digestibility by the bacteria was about the same as for hay.

With still longer exposures, digestibility was again reduced. Apparently, the cellulose was then destroyed, for sawdust that has been irradiated for such long periods becomes completely soluble in water; cellulose itself is quite insoluble. Sawdust has been used in Europe for cattle fodder by giving it a sulphuric acid treatment.

Note: This may refer to overcooking in the sulphite process which breaks down the liquid and makes the cellulose available for disgestion in the rumen. It is believed that the cathode ray treatment may prove simpler and less expensive.

* * *

Russell C. Weigel has been appointed Assistant Manager of the du Pont Co.'s Polychemicals Department Planning Division. Mr. Weigel was in charge of sales to the paper, textile, and leather industries. Jerry D. Shaw was named to succeed Mr. Weigel.

* * *

Starting of a double-track program, destined to materially increase the manufacturing breadth and the industry-service scope of Wyandotte Chemicals Corporation, was announced today by Robert B. Semple, President.

The program will involve the three chemical manufacturing and compounding plants located in Wyandotte, a suburban community on the Detroit River, eleven miles southwest of Detroit; the limestone quarries at Alpena, Mich.; the clay operations at Blue Mountain, Miss.; and the compounding plant at Los Angeles, Calif.

Wyandotte, a 61-year-old producer of alkalis, is a major manufacturer of three of the four most essential industrial chemicals—chlorine, soda ash, and caustic soda. Within the last few years it has expanded into the organic field and has developed a number of products in the field of detergents and industrial cleaning compounds. In recent months, the company has gained an important position in the railroad and aircraft industries.

The activity now projected will not only increase the output of the three basics (chlorine, soda ash, and caustic soda) but will provide processing facilities which will permit the company to upgrade the present line of products, with emphasis in the organic field.

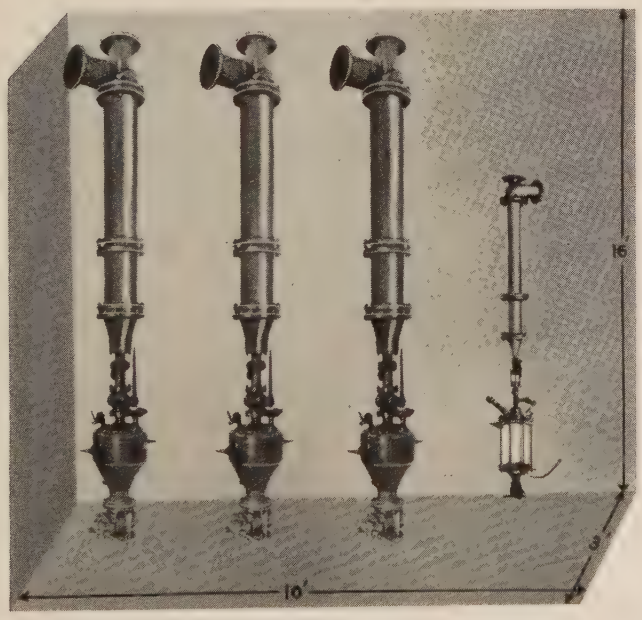
use VORTRAPS

IF Your Pulp Mill Is . . .

SQUEEZED For Space . . .

PRESSED For Quality . . .

Hounded For Production



The above installation of three 10″ and one 4″ Vortraps will handle *150 TONS* daily production at 0.75% consistency.

(Note the space requirements)

- Better Quality
- More Screen Capacity
- Less Labor
- No Rifflers
- Less Building Requirements
- Less Maintenance
- Less Stock Waste

NICHOLS ENGINEERING & RESEARCH CORPORATION

70 Pine Street — New York 5, N. Y.

40 So. Los Robles Ave. Pasadena 1, Calif.—1477 Sherbrooke St., W. Montreal 25, Canada

The initial phases of the program, to be carried out within the next 24 to 36 months, provided equipment is available and no unforeseen difficulties in construction are encountered, will be followed by additional projects now under consideration in the Research and Development division and the Manufacturing Engineering Department. The expansion, therefore, will move forward on a never-ending basis.

The expansion plans have been under study for the last year and a half, and while these are based primarily upon the economics of civilian needs, they do anticipate the extraordinary requirements of the preparedness program. This is particularly true in the additional chlorine and soda ash units which will be installed, since both chemicals are in serious short supply and of vital importance to the industrial mobilization of the nation.

Ground already has been broken in Wyandotte for a new research pilot plant and the Wyandotte Research Center. The Research Center will be approximately a city block and a half long, and a half block wide. It will be next to the company's Administration Building on Wyandotte's main thoroughfare. Occupancy of the building, which will house all the scientific and technical groups under the supervision of Thomas H. Vaughn, Vice-President in charge of research and development, is scheduled for mid-1952.

The Center will be a functionally engineered, two-story structure, of modern architectural design. Interior construction on a 10-foot module basis will permit changes in laboratory size and arrangement with a minimum of disturbance to research activities. Included in the Center will be special areas devoted to exploration in such fields as radioactive tracers, nucleonics, electronics, organic and inorganic chemistry, sanitation and germicides, electroplating, physics, and the entire field of commercial cleaning served by the company's dishwashing compounds, laundry detergents, and metal and industrial cleaners.

OBITUARIES

Edgar E. Morris

Edgar E. Morris, Works Manager of the Brown Co., Berlin, N. H., died on Tuesday, Mar. 27, at the Maine General Hospital in Portland, Me.

Mr. Morris was born in Gorham, N. H., on Feb. 10, 1895. In 1912 at the age of 17 he went to work for the Berlin Mill Co. in the saw mill and a short time later, after that mill burned down, he went to work on the paper machines of the International Paper Co. He joined the Brown Co. in 1917 as a cost accountant. In 1932 he was named Superintendent of the Paper Division, which included the Cascade and Riverside Mills. In 1944 he was promoted to works manager and was responsible for all manufacturing operations of the Company.

L. V. Frisch

L. V. Frisch, Mill Manager of the Fir-Tex Insulating Board Co., St. Helens, Ore., died on Dec. 5, 1950. Mr. Frisch was born at Bonners Ferry, Idaho, on Sept. 29, 1908, and graduated as a mechanical engineer in 1936 from the University of Idaho. Prior to joining Fir-Tex, Mr. Frisch was employed by Potlatch Forests, Inc., Shell Oil Co., and Weyerhaeuser Timber Co.

Harold F. Bullard

Harold F. Bullard, Vice-President of Finch, Pruyn & Co., Glens Falls, N. Y., died on Apr. 16 at the New England Deaconess Hospital, Boston, Mass.

Mr. Bullard was born in Schuylerville, N. Y., on Nov. 20, 1888, the son of Edward C. and Ida (Burnays) Bullard. His father was a prominent paper manufacturer in Schuylerville.

He graduated in chemistry from The Rensselaer Polytechnic Institute, following which he was employed two years as a chemist for the Imperial Paper & Color Corp. in Glens Falls. In 1912 he went with the Laurentide Co. Ltd. at Grandmere, P. Q., as a chemist. In 1923 he became Manager of the Dryden Paper Co. of Dryden, Ont., and in 1925 he was made Assistant to the President of Finch, Pruyn & Co. Inc., becoming Vice-President and Secretary in 1935.

In addition to his wife Mildred M. (Moyle) of Lancaster, N. H., Mr. Bullard is survived by two sons, Edward C. Bullard, who is associated with Perkins-Goodwin Co. in New York, and John F. Bullard of Glens Falls, N. Y.

J. D. Jenssen

Jacob Darre Jenssen of New York City passed away at St. Luke's Hospital in New York late Monday evening, April 16, after an extended illness.

Mr. Jenssen was born at Trondheim, Norway, on June 9, 1876. He was co-founder of the G. D. Jenssen Co. of Watertown, N. Y. Mr. Jenssen acted as personal consultant and designer for many pulp projects in North America and on the European continent.

Mr. Jenssen came to the United States in 1900 and engaged in engineering design with several pulp and paper mill consultants. He was associated with Hardy S. Ferguson Millenocket, Me., until 1905 when he returned to Europe. He was engaged by Hungarian interests for several months and then transferred to Koenigsberg, Germany, with the Nordeutsche Cellulosefabrik.

In 1909, he returned to North America as chief engineer for the Riordan Co. at Hawkesbury, Ont. In 1915, together with his brother, Gunnar D. Jenssen, he founded the firm of of G. D. Jenssen Co. Mr. Jenssen introduced the reversible two-tower system of sulphite acidmaking which is used in the majority of the pulp and paper mills throughout the world. There are installations in North and South America, Europe, and Asia.

Many mechanical developments are attributed to Mr. Jenssen, particularly in the field of acidmaking. He designed several pulp mills and contributed process improvements in almost every sulphite pulp mill built since 1920.

The G. D. Jenssen Co. was incorporated in May, 1944, with Mr. Jenssen as president. In 1949, Mr. Jenssen relinquished his official capacity as an officer to remain as technical consultant and adviser to the company.

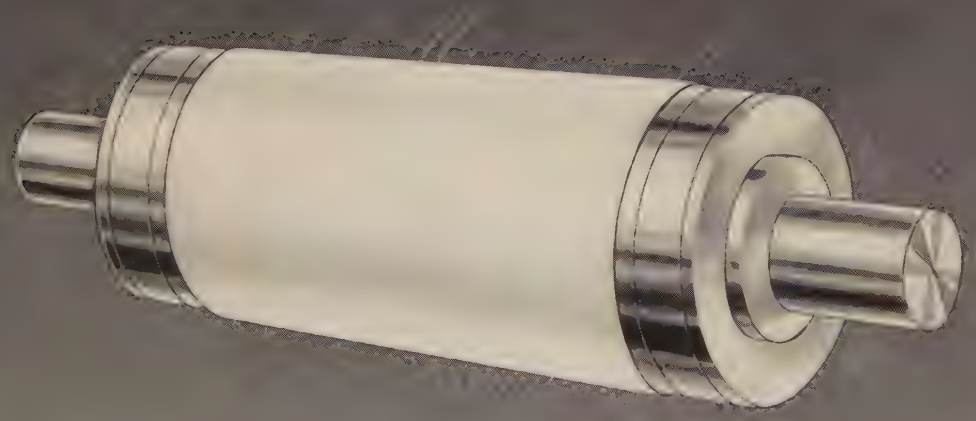
Mr. Jenssen was educated in his native Norway and graduated from technical college at Trondheim, Norway. He later took postgraduate work at Karlsruhe, Germany.

Mr. Jenssen was a naturalized American citizen. He was one of the original members of the Technical Section of the Canadian Pulp & Paper Association, and also one of the original members of the Technical Section of the Pulp & Paper Industry (TAPPI) in the United States. He was also a member of the Verein Der Zellstoff Und Papier Chemikar, Germany.

Mr. Jenssen is survived by his sister, Wilhelmina Jenssen, of Norway.

Funeral services were held on Thursday, April 19, at The Abbey, 132 East 70th Street, New York City.

"HOLYOKE"
CALENDER ROLLS



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TAPPI DIVISIONS AND COMMITTEES

Recent Reports of Activities

Papermaking (Fourdrinier) Committee

Those in attendance at the Papermaking (Fourdrinier) Committee meeting on Feb. 19, 1951, were:

Noel R. Phillips, *Chairman*, Champion Paper and Fibre Co., Canton, N. C.
Robert G. Hitchings, *Secretary*, New York State College of Forestry, Syracuse, N. Y.
Harry S. Spencer, Howard Smith Paper Mills, Ltd., Beauharnois, Quebec, Canada.
Hugh H. Morton, S. D. Warren Co., Cumberland Mills, Me.
Everett P. Ingalls, Jr., S. D. Warren Co., Cumberland Mills, Me.
William J. Foote, Jr., Consolidated Water Power and Paper Co., Stevens Point, Wis.
Lawrence P. Thompson, The Personal Products Corp., Milltown, N. J.
Thomas M. Barry, Hollingsworth & Whitney Co., Waterville, Me.
Richard Flores, Riegel Paper Corp., Riegelsville, N. J.

During the course of the committee meeting the chairman, Mr. Phillips, called for suggestions for three closed meetings to be held at the 1952 TAPPI Annual Convention. The suggestions included the topics of the effect of the shake, the problems of surface sizing, and the problems of drying as related to paper manufacture. A need was stressed to obtain suitable men to lead the discussions in the closed meetings. The meeting on paper defects will of necessity have to be extended into the 1952 Convention, due to the nature of the material to be covered. Future meetings of the Fourdrinier Committee will most likely all be held on an invitation basis only.

To broaden and increase interest in the closed discussion meetings, questionnaires might be sent to companies who have an interest in these papermaking problems, the questionnaires summarized and used as a basis for the views to be aired in closed sessions. A further suggestion was added that questions be solicited from men in industry on the discussion problems previous to convention and these questions circularized previous to the closed meetings in order to bring out more concise and thorough answers.

Due to the differences in sheet characteristics of the many grades made on fourdrinier paper machines, it was proposed that three subcommittees be set up to facilitate the work of the Papermaking (Fourdrinier) Committee. The tissue subcommittee to include the lightweight grades of fourdrinier sheets and cigarette paper was established with Lawrence P. Thompson as chairman. The other two subcommittees will be appointed by Mr. Phillips in the near future. One subcommittee will be concerned with the medium-weight fourdrinier sheets as bond, writing, and coating base stocks and the other subcommittee will cover the papermaking problems of the heavy fourdrinier grades as kraft bag and board sheets.

To increase the progress of the committee's work, a proposal was discussed by its members on the advisability of obtaining a grant from the Technical Association of the Pulp and Paper Industry in order to send a qualified person to the various member mills in order to collect data on definite problems. It would also be this person's duties to discuss and orient the thinking of the mills to the problems under consideration to attain a scientific, accurate understanding and solution for these problems. The suggested problems included the relationship of sheet characteristics and slice adjustments, the improvement of fourdrinier wire life, the selection and design of suction box covers, and elimination of inherent sheet defects, i.e., grainy edges, curl, and cockle.

Pressure formation, use of various materials for suction b covers, wire life, and use of the Mt. Hope Expander roll we thoroughly discussed.

Robert G. Hitchings, *Secretary*
N. Y. State College of Forestry, Syracuse, N.

Preparation of Papermaking Materia Committee

The Preparation of Papermaking Materials Committ met in New York on February 19. The membership of th committee is as follows:

F. S. Klein, *Chairman*, Byron Weston Co., Dalton, Mass.
J. P. Bainbridge, Jr., Monsanto Chemical Co., Everett, Mas
J. G. Bullard, Corn Products Refining Co., New York, N. Y
R. G. Mispley, Crown Zellerbach Paper Co., Camas, Wash.
L. A. Moss, Whiting-Plover Paper Co., Stevens Point, Wis.
R. J. Proctor, Fitchburg Paper Co., Fitchburg, Mass.
J. F. Theriault, Robert Gair Co., Haverhill, Mass.
F. L. Simons, Crane & Co., Dalton, Mass.

Significance of Sizing Tests Subcommittee

Fine Papers	*Coarse Papers*
L. A. Moss, *Chairman*	R. G. Mispley, *Chairma*
F. L. Simons	J. F. Theriault

Outline of Material Preparation Methods Subcommittee

F. S. Klein, *Chairman* L. A. Moss

Of the projects listed from previous meetings it was decide to concentrate on two, the filler monograph and the signi cance of sizing tests. The opinion was expressed that th committee has been trying to cover too many widely separate projects and should try to concentrate on one or two which a in various stages of progess and to start preliminary work on third which can be expanded in 1952.

I. Filler Monograph. This is in an advanced stage an Bob Proctor will no doubt report on this in a few month It is my understanding that the project is complete except fo two items which he hopes to have written this spring.

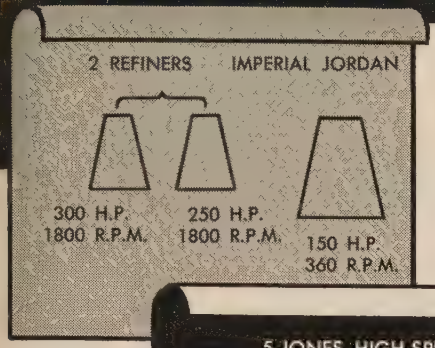
II. Significance of Sizing Tests. Most of the member expressed an interest in this project and it appears to hav bogged down simply because sizing tests are peculiar to eac mill and laboratory. Bob Mispley has done quite a bit o work in this line, but lacking outside contacts has been unabl to put the work on a broad basis and feels that what he ha done is restricted to his own field of paper and experience.

The committee plans to remedy this as follows:

1. The chairman will contact suppliers and manufacturer of rosin sizes sending them check lists of sizing tests which the committee thinks are in use to see if it can find out hov widespread their usage is on the basis of how frequentl their field service men come in contact with them.

2. The information derived from step 1 will be divide into Writing, Printing, and "Utility" papers and will be sen to Al Moss, who will handle Writing and Printing papers, an Bob Mispley, who will handle "Utility" papers. In each group they will take the most widely used tests and frame a questionnaire to be sent to mills manufacturing the types o paper included in the group.

3. We hope that these two statistical questionnaires wil point to certain individual tests which enjoy wider acceptanc than others and should form a nucleus for trying to arrive a some idea of the "significance" of the tests by either of, or a combination of, the following:



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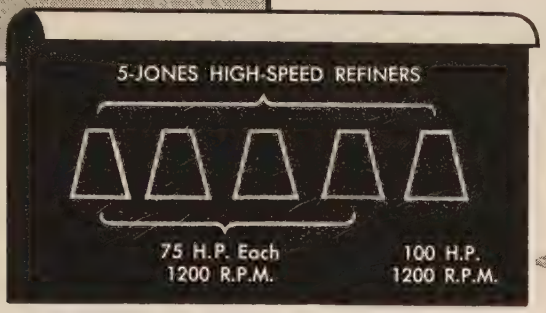
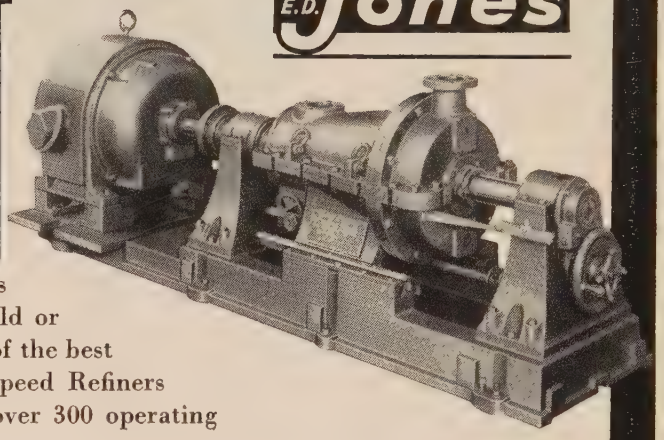


E.D. Jones



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E. D. Jones & Sons Company, Pittsfield, Mass.

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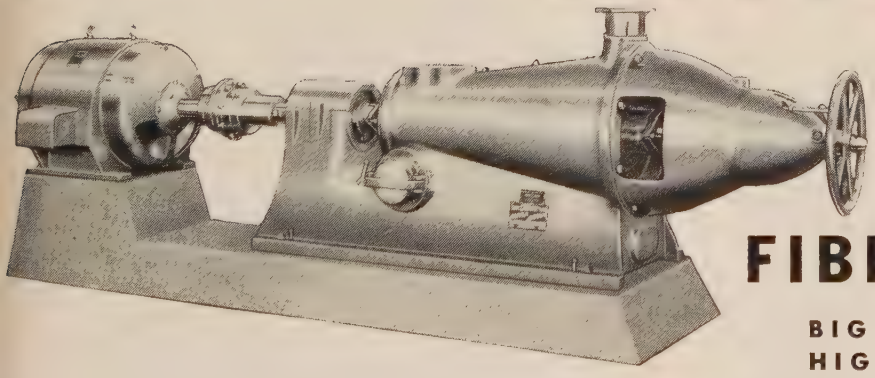

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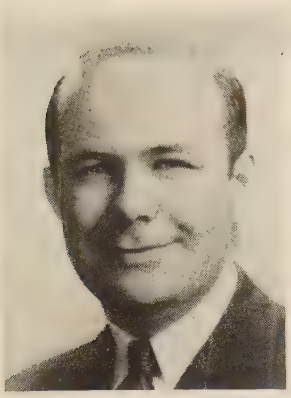
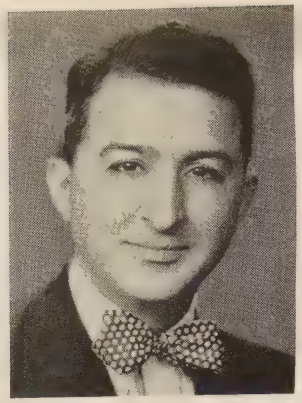


Noel R. Phillips, Chairman, Papermaking (Fourdrinier) Committee



Henry Vranian, Chairman, Alkaline Pulping Committee

A. Asking for opinions from those who use them, or
B. Sending groups of samples of given types of paper to representative mills for checking tests to see if:
   (1) Results are reproducible in different laboratories.
   (2) Interpretations of results are uniform.

4. If this program can be followed through we hope to have available

A. Statistical information on acceptance and usage of sizing tests as used on different types of paper.
B. Some idea of the tests' reproducibility (and therefore reliability).
C. Summary of the tests' significance as reflected by general comment.

III. Outline of Material Preparation Methods. This project is one which I personally feel is needed in my own mill experience. The idea is briefly that while the methods of preparing such simple things as alum solutions, melamine resins, rosin size emulsification and conversion, etc., are scattered throughout the literature, there is no single bulletin or reference volume in which all of them are presented in an up-to-date form which consists of both the suppliers' recommendations and the papermakers' practical adaptations. If the idea is acceptable, I thought he and I would start this year by getting a few suppliers to write up their preparation methods and perhaps next February, if it is "in the works," we can arouse some interest and expand the program. The general idea would be to ask suppliers to submit their latest recommendations, to have a committee review them, and in cases where recommendations and actual practice seem far apart to follow up with a questionnaire to the mills.

F. S. Klein, *Chairman*
Byron Weston Co., Dalton, Mass.

Alkaline Pulping Committee

The annual meeting of the Alkaline Pulping Committee was called to order at 2 p.m. February 19 at the Commodore Hotel, New York City, and the Chairman, Henry Vranian, was unanimously re-elected for the year 1951. The minutes of the previous meeting were read, approved, and formed the basis of the agenda.

The committee felt that the 1950 Fall Meeting held in Jacksonville, Fla., had been such an outstanding success that an Alkaline Pulping Meeting should be held this coming Fall. After considering Mobile, New Orleans, Birmingham, and Richmond, it was the recommendation of the Alkaline Pulping Committee that the next Fall Meeting be held in Richmond, Va., on Sept. 26, 27, and 28, 1951. It was pointed out that there would be wholehearted support from the member mills close by at West Point, Franklin, Roanoke Rapids, Hopewell, and Plymouth, all of which are within a short distance of Richmond.

At the previous annual meeting it had been suggested that the 1951 Fall Meeting be devoted to the topic "Wood Preparation and Cooking Procedures" with 1 day devoted to general papers. After considerable discussion, it was decided that this subject was of paramount interest to the industry, but the consensus was that the program be enlarged to cover semi-chemical processes. Bob Fuller was asked and consented to act as Program Chairman for this September meeting. As such, Chairman Fuller was asked to send a copy of our publicity letters to all mill management, emphasizing that this Fall Meeting was devoted to practical discussions on operating problems. About fifteen tentative papers from mills were obtained, copies of which were turned over to the Program Chairman.

The committee further suggested that the 1952 committee develop a fall program devoted to Evaporators and Recovery Units, which would also include such subjects as precipitators, odor abatement, sulphur, and soda recovery.

K. O. Elderkin of the Executive Committee stated that funds were now available to undertake projects of research and investigation that would be of benefit to the various committees. In order to speed up such undertakings, it was further suggested that the committee contact and recommend the organization that would carry out such investigations. The Alkaline Pulping Committee felt that a "quick method of determining the degree of delignification of a high yield pulp" was of such importance to the industry as to warrant a request for assistance. Accordingly, P. Borlew was appointed chairman of a subcommittee to prepare this application in approved form and submit same to Mr. Vranian, who will then see that it is presented to the Executive Committee. Other requests for research appropriations may come up during the present year; again, these should be referred to the chairman for consideration at a midyear committee meeting.

The committee feels that it has a few suggestions for revision of the TAPPI Standards and routine control methods. P. Borlew kindly consented to contact the various mills and secure from them the methods now in use, together with suggested revisions and additions to the present TAPPI Standards and data sheets. These should be available by July.

The Alkaline Pulping Committee membership is as follows:

Henry Vranian, *Chairman*, Chesapeake Corp. of Va., West Point, Va.
K. D. Running, *Secretary*, Halifax Paper Co., Roanoke Rapids, N. C.
Fred C. Goodwill, St. Regis Paper Co., Kalamazoo, Mich.
K. O. Elderkin, Crossett Paper Mills, Crossett, Ark.
Phillip J. Hannan, Southern Advance Bag & Paper, Hodge, La.
Erik Zimmerman, Chesapeake Corp. of Va., West Point, Va.
Robert E. Bowen, N. C. Pulp Co., Plymouth, N. C.
H. G. Bickley, W. Va. Pulp & Paper, Williamsburg, Pa.
Everett D. Cann, Howard Smith Paper Mills, Cornwell, Ont.
R. H. Stevens, National Container Corp., Jacksonville, Fla.
Robert R. Fuller, Gulf States Paper, Tuscaloosa, Ala.
Rudolph T. Greep, S. D. Warren Co., Cumberland Mills, Me.
Kenneth G. Chesley, Crossett Lumber Co., Crossett, Ark.
Paul Gilmont, Crossett Lumber Co., Crossett, Ark.
Peter B. Borlew, Container Corp. of America, Fernandina, Fla.
C. L. Smith, National Container Corp., Jacksonville, Fla.
W. W. Marteny, National Container Corp., Tomahawk, Wis.
L. E. Goodwin, Macon Kraft Co., Macon, Ga.
G. C. Kimble, Union Bag & Paper Co., Savannah, Ga.
C. M. Adams, Southern Paperboard Corp., Savannah, Ga.
F. L. Jones, St. Joe Paper Co., Port St. Joe, Fla.
David Wetherhorn, Southern Paperboard Corp., Savannah, Ga.
Ralph H. McGee, Consulting Engineer, New York, N. Y.
J. J. Goss, Gaylord Container Corp., Bogalusa, La.

K. D. Running, *Secretary*
Halifax Paper Co., Roanoke Rapids, N. C.

Chemical Products Committee

The Chemical Products Committee met in New York on February 19. Those present were:

Arthur Pollak, *Chairman*, New York, N. Y.
Frederick H. Gayer, Continental Research Corp., Chicago Heights, Ill.
Richard Herrlinger, Arizona Chemical Co.
William P. Newman, Jr., Southern Advance Bag Corp., Hodge, La.

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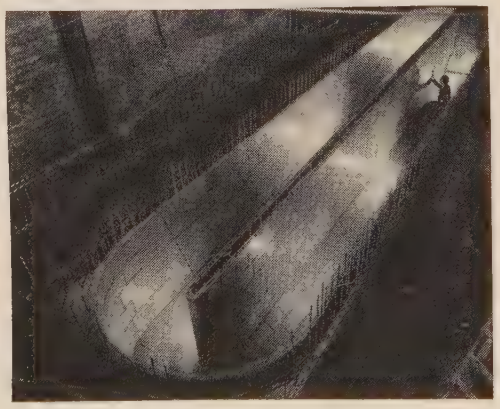

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John M. McEwen, Chairman Acid Pulping Committee

A. S. Erspamer, Chairman Water Committee

The discussion was limited to tall oil. It was agreed to make a survey among producers in the sulphate pulp industry to provide a comparison of yields of skimmings from which tall oil is made. Tall oil is now in short supply.

Acid Pulping Committee

The Acid Pulping Committee met at the Hotel Commodore in New York City on Feb. 19, 1951.

The committee decided not to attempt to sponser a National Acid Pulping meeting. It was thought that acid pulping is too much divided geographically. Even a central location for such a meeting would mean a limited attendance from the East and West Coast, since few mills would send more than one man, and many small mills would send none. It was decided that each of the three subcommittees would cooperate with the local section in its area in presenting acid pulping material. Papers of national interest would be presented at the next February meeting.

The committee plans to continue to operate with regional subcommittees. Each subcommittee will meet under its chairman and work on the acid pulping problems in its area. Common problems are waste liquor disposal and sulphur economy. Special problems include hardwood utilization for the Eastern group, resinous woods for the Lake States group, and the use of ammonia and magnesium bases for the West Coast group. Each subcommittee will see that a paper is presented at the New York annual meeting.

The possibility of using TAPPI funds for acid pulping research was discussed. No new projects were recommended. The committee was notified of the approval of a project that it had previously recommended, a study of the Thermodynamic Properties of Ammonium and Magnesium Bisulphite Solutions. This work will be carried on with a TAPPI research grant under J. L. McCarthy at the University of Washington, Seattle, Wash.

The sulphur shortage was discussed. A committee report on the reasons for the wide variation in reported sulphur consumption per ton of pulp was reviewed. This report was later presented by the committee chairman, John M. McEwen, as a part of the acid pulping program.

JOHN M. MCEWEN, *Chairman*
Weyerhaeuser Timber Co., Everett, Wash.

Water Committee

The Water Committee Meeting was held in the Grand Ballroom of the Hotel Commodore on Monday afternoon, Feb. 19, 1951, with the following present: A. S. Erspamer, *Chairman;* W. A. Tanzola, R. B. Martin, E. N. Poor, C. L. Anderson, Arthur Thurn, J. J. Priest, J. N. Stephenson, and W. Kaufman.

Mention was made of the fine Water Committee work Miss Louise McGrath had done in the past. Her absence at this and last year's TAPPI meeting was felt. The hope was expressed that she soon would be enjoying her usual good health.

Messrs. Anderson, Thurn, and Priest are new men who are interested in Water Committee work. Their names have been formally submitted for admission to the Water Committee as members of the advisory subcommittee.

The subject of the chapter on Water in Volume IV of the new series of textbooks on Pulp and Paper Manufacture was brought up by J. Newell Stephenson, Editor-in-Chief of the Joint Textbook Committee. Since the second TAPPI Water Monograph was progressing so slowly because of the difficulty in securing authors, it was decided to temporarily suspend work on this project and utilize the time working on the Chapter on Water for Volume IV of the new textbook. E. N. Poor will handle the re-editing of the chapter with assistance from R. B. Martin.

The new direct colorimetric titration method for determining the hardness of water was discussed. W. A. Tanzola agreed to check into the present ASTM status of this method. In the event the method is well on its way to adoption by ASTM, it was suggested that it be proposed as a TAPPI Standard procedure.

The annual program for 1952 was briefly discussed. Two tentative papers were lined up, one by J. Howard Wright, S. Austin Bicking Company, Downingtown, Pa., on the Oco system and the other, "An Integrated Rag Mill Waste Treatment Plant," by C. S. Rankin, Chief Engineer, Continental Diamond Fiber Co., Newark, Del., and John E. Tarman, Director Consulting Division, W. H. & L. D. Betz, Philadelphia, Pa. The suggestion was also made placing emphasis on obtaining papers on mill saveall equipment.

A. S. ERSPAMER, *Chairman*
P. H. Glatfelter Co., Spring Grove, Pa.

Microscopy Committee

The Microscopy Committee met at 4:00 p.m. Feb. 21, 1951, in the Commodore Hotel, New York City. Those present were: C. E. Brandon, *Chairman;* T. L. Fyfe, F. D. Houghton, H. C. Koch, T. G. Rochow, R. H. Simmons, F. L. Simons, and E. R. Wand (visitor). H. C. Koch was appointed secretary pro tem.

After a discussion of TAPPI Standards T 8 and T 10, it was agreed that new photomicrographs should be prepared for these. Otherwise, these standards were considered satisfactory. It was suggested that some of the photomicrographs needed may be available from the New York State College of Forestry. Mr. Brandon offered to see Mr. Donofrio in regard to these photomicrographs. The TAPPI "Fibrary" was suggested as a source of samples needed for other photomicrographs. Dr. Simons offered to prepare any needed slides on nonwoody fibers.

It was agreed that a questionnaire on TAPPI Standard T 445 would be circulated among the committee members to determine with which tests they are familiar, which tests need revision, which are satisfactory, and what tests should be added. Mr. Wand offered to submit a copy of the scheme of speck analysis which he uses.

A number of the committee members held two previous meetings on February 19 and 20 to discuss TAPPI Standard T 401. All agreed that a revision of this method is in order and it was decided that the committee should prepare one at an early date. Since time was very short, these previous meetings were considered to be sufficient and only a brief mention was made of the project in this meeting.

The possibility of preparing a suggested method for determining fiber length was discussed. It was decided that three methods familiar to members of the committee would be prepared for publication as routine control methods. Messrs. Fyfe and Wilson will each write their own methods and Mr. Simmons will write Dr. Clark's method for this purpose.

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The identification of paper fillers was discussed briefly. It was decided that Mr. Koch would write a method for the committee's consideration.

It was the consensus that a separate method for the identification of synthetic fibers in piece goods is preferable. Mr. Houghton agreed to write up a routine control method. At present, only a reference to synthetic fibers is given in TAPPI Standard T 401.

The subject of a microscopic method for the determination of degree of beating was discussed, and Dr. Simons was requested to write a routine control method.

The committee wished to investigate the extent to which the microscope is used for the identification of nonfibrous organic materials used in paper and Dr. Rochow offered to prepare a report for the committee to use in its preliminary work on this subject.

The identification of printing was discussed briefly and Mr. Simmons agreed to write a report on this.

The color photomicrographs prepared at Eastman Kodak Co. of various wood fibers stained with C stain were discussed. Mr. Fyfe stated that 35 mm. color transparencies were being made, and that these would be considerably cheaper to reproduce. It was decided that further action would be postponed until the 35 mm. transparencies are ready.

The committee discussed at some length the possibility of writing a monograph on Microscopy. Mr. Brandon submitted a suggested outline of topics to cover in this monograph. This received favorable comment. It was generally agreed that such a publication should accomplish three purposes, as follows: it should encourage wider use of the microscope, it should serve as a text to educate and train beginners in miscroscopy, and it should also serve as an encyclopedia to the advanced or expert microscopist. It was decided that the committee would undertake this project.

The chairman mentioned a number of other subjects which are awaiting the committee's consideration. These subjects included: cross sectioning of papers and fibers, the TAPPI "Fibrary," and fiber weight factors. However, time did not permit more than this mention.

H. C. Koch, *Secretary*
Howard Paper Mills, Inc., Dayton, Ohio

TAPPI-ASTM Technical Committee on Petroleum Wax

The TAPPI-ASTM Technical Committee met at the Shoreham Hotel, Washington, D. C. on February 7–8 and discussed the following projects:

II. Flow Tests

Mr. Kenneth Coutlee of the Bell Telephone Laboratories has resigned as chairman and was replaced by: Hans Schindler, Daugherty Refinery, L. Sonneborn Sons, Inc., Petrolia, Pa.

Adaptation of the penetration test ASTM D 5 – 25 was discussed. The use of a brass cylinder on a brass plate to prepare the sample was proposed. The surface in contact with the plate is used after removing the plate, to get a smooth flat surface for penetration. Round-robin tests on two paraffin waxes and two microwaxes are to be conducted. Other possible variations in the penetration test are to be considered.

It was agreed that there was a definite need for a standardized flexibility test. More information is needed on the type of flexibility test required and the chairman has since circularized the consumer interests for comments on use requirements for flexibility and also for viscosity tests.

III. Stability Tests

Accelerated oxidation testing was discussed. The conditions chosen for further study were 275°F. to 50 peroxide number. An objective chemical test such as peroxide number seemed preferable to odor as a criterion of wax deterioration. Four waxes will be supplied to participating laboratories who will study other temperatures as desired. The oven life at 180°F. will also be determined for correlation.

The general feeling was that peroxide number would be satisfactory for paraffin waxes but that for dark microcrystalline waxes it may not be satisfactory due to natural retardants. With full refined light-colored paraffins sufficient concentrations of oxidation retardants to cause difficulty is not anticipated.

Other methods including one based on direct measurement of oxygen absorption will also be considered.

V. Composition

The Advisory Committee has recommended discontinuance of the activities of Section V-B, at least for the time being. Its activities were more of a research nature and it is desired to concentrate on test method development. J. B. Rather, Chairman of Section V, has recommended that ASTM D 2, Section III on Paraffin Wax, of which he is also the Chairman, be discontinued and plans to consolidate Subcommittee III activities with Section V.

Section V has been very active in the development of methods for determining oil content and is now concentrating on microcrystalline wax. Comments from consumers on the scope and use of such a method would be welcomed by the committee.

The committee met again at the Commodore Hotel, New York on February 19 and discussed the following projects.

VI. Blocking

The section members have had considerable success with their mercury method described at the TAPPI Testing Conference held at Rochester last Fall. They are still worried about the use of mercury from a safety point of view and are looking for substitutes. This section soon expects to be in a position to propose a standard blocking test procedure.

VIII. Scuff and Gloss

This was the first meeting of the committee. After a brief general discussion on the properties of scuff and gloss, there was more detailed individual discussion of these properties. A survey of the group on the methods used revealed that they include the finger test, a variation of the Tabor Scuff Tester method, and the Marathon method. Various additional suggestions were made and the committee decided to conduct a round robin to compare proposed method on samples to be supplied by the chairman.

The discussion on gloss revealed that all instruments used at present are based on the reflectance principal, using a light source and a photoelectric pickup, but the angles of light source and pickup vary from 15 to 60°. It was agreed that these angles are critical and it was decided to compare results on the various available instruments using samples to be supplied by the chairman.

Other Activities

Section VII on Sealing and Laminating under George C. Borden, Jr., met individually on December 8 in New York to accelerate its program. Section I, on Strength Tests under J. W. Padgett, has been very active through committee correspondence.

As a matter of general interest, it might be mentioned that the meetings in Washington with the ASTM were attended mostly by producer members and it appears desirable to hold future meetings in connection with TAPPI to assure good consumer representation. Dr. Heald has been informed that the British Institute of Petroleum has set up a committee on Petroleum Wax chairmaned by T. C. G. Thorpe of the Anglo-American Oil Co. They have used our committee as a model and plan to keep in close touch with us.

WOOD PULP

●

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Nensjo
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Ostrand

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LOCAL SECTION ACTIVITIES

Reports of Meetings, Personnel and Events

Kalamazoo Valley

Controversial ideas on coating paper to improve its printing performance sparked a 2-hour discussion at a joint meeting of the Kalamazoo Valley Section and the Michigan Division, American Pulp & Paper Mill Superintendents Association on May 5, 1951.

Glenn Davidson, Aurora, Ill., was the speaker. He addressed an audience of 105 men, among them many from coating mills in Pennsylvania, Indiana, and Ohio. J. J. Harrison, Michigan Carton Co., and O. W. Callighan, Edgar Brothers Co., presided jointly.

Mr. Davidson, an expert in the use and production of soybean protein, talked on "The Influence of Adhesives in Coated Papers on Printing Performance."

Members of the panel included A. T. Luey, Sutherland Paper Co.; Leon H. Mimms, Kalamazoo Paper Co.; Harrison Kindig, MacSim Bar Paper Co.; Henry Nendorf, Rex Paper Co.; Martin Galbraith, Sutherland Paper Co.; and Richard J. Grimm, St. Regis Paper Co.

Mr. Davidson's first major contention was that most off-the-machine coating stocks are oversized as far as beater sizing is concerned.

This statement is supported in part by the findings of J. P. Casey and C. E. Libby as published in *Tech. Assoc. Papers* 31: 172–185 (June 1948). This work deals with a study of the coating of carefully prepared handsheets in which the entire history of the base stock is recorded. The work of Casey and Libby shows in the case of the starch-clay coatings that decreased amounts of rosin sizing in the base stock increase both the wax number and the Case ink receptivity of the sheet. This trend is observed to a lesser extent with casein-clay coated sheets. Smoothness and evenness of ink receptivity are poor on the sheets having no rosin content when 40% solids coatings are applied.

Mr. Davidson said that evaluations of commercial base stocks in his laboratories tended to confirm Casey's and Libby's results. Some of this work, reported by C. R. Singleterry in Ann Arbor in 1940, showed that comparable body stocks with different degrees of beater sizing could be ranged in the following order: hard sized, coating pick with separation from body stock; medium sized, coating pick and partial body stock pick; soft sized, complete body stock pick. This would tend to substantiate the evidence previously presented; however, Singleterry's work seemed to show the correlation between decreased internal sizing and increased pick resistance with casein coatings as well as with starch coatings. These findings have been consistently confirmed by means of the Davidson-Pomper pick tester.

In presenting evidence concerning this difference in bonding noted in various sheets, Mr. Davidson explained a method of preparation of cross-sectional slides for microscopic study of coated sheets developed in his laboratories. The technique involves curing of methyl-methacrylate monomer around $^1/_4$-inch strips of the coated paper to be studied. Thin sections of the cured Lucite resin containing the paper are then cut, polished, and studied microscopically. Two idealized drawings of slides prepared by this technique showed that off-the-machine coating body stocks coated with a 40% solids color have only keying of the coating to the top layer of the body stock, while the top fibers of an on-the-machine coating body stock "explode" into the coating. The success of on-the-machine coating of extremely slack sized sheets is only possible because of the high viscosity of the coating colors containing approximately 60% solids.

In aiding coaters to locate the point of minimum effective rosin content, it was suggested to use ultraviolet or "black" light. Mr. Davidson felt that he could see the fibers which have exploded from the surface of the body stock into the coating. Use of an ink smear before black light viewing was recommended as an aid in this method of control. Smoothness tests and Case ink receptivity were also recommended as good supplementary tests.

Another point raised by the speaker dealt with the differential penetration of binder and pigment in a coating mixture. An investigation of this matter in the Davidson Laboratories showed that from 5 to 12% of the adhesive in the coating penetrated into the body stock. Other investigators were quoted as finding penetration limited to from 3 to 4%. Assuming a 5% penetration, about one eighth of a pound of adhesive per ream would be the maximum leaving the coating and entering the body stock. Mr. Davidson maintained that this amount is insufficient to improve the strength of the body stock. He listed three recent instances which seemed to substantiate this idea. The coaters had added casein to adjust for a low wax test, but Scotch tape tests and Davidson-Pomper pick tests have shown no noticeable improvement. As the result of the addition of casein the printer was in a worse position because of the lower ink receptivity.

If the printer has a sheet of a high ink receptivity, he can reduce the tack of his inks and minimize the pull of the ink on the coating of the sheet. On the other hand, if he has a sheet of low ink receptivity, he must use relatively tacky inks resulting in greater pull on the coating. High ink receptivity helps break the ink film between the printing plate and the sheet. Accordingly, coated sheets with relatively low wax numbers and high ink receptivity may be excellent sheets for offset printing. The speaker reported that an article in *Inland Printer* by Charles F. King, Technical Director of the U. S. Printing and Lithographic Co., may be interpreted to say that a fortunate combination of high ink receptivity and a printer's skill permits use of sheets with relatively low wax numbers.

At this point, the meeting was open to questions from members of the audience and the panel. Mr. Nendorf asked how the waterleaf coated sheets were dried in the laboratory. Mr. Davidson replied that they were dried in a hot air blast from a hair drier to simulate conditions on a festoon drier.

Mr. Kirkpatrick asked about the effect of pH and alum on coated sheets. Mr. Davidson stated that a high alum body stock tends to precipitate or coagulate a protein adhesive at the interface between coating and body stock, reducing penetration to a minimum.

Mr. Callighan asked about the possibility of eliminating alum and size in the beater and applying a surface film of starch at the size tub. Mr. Luey answered the question by stating that good coating is often obtained in the production of coated boxboard when there is little or no internal sizing on the sheet. He also stated that he had seen excellent sheets of this nature produced without use of wax or rosin emulsions at the calender stacks.

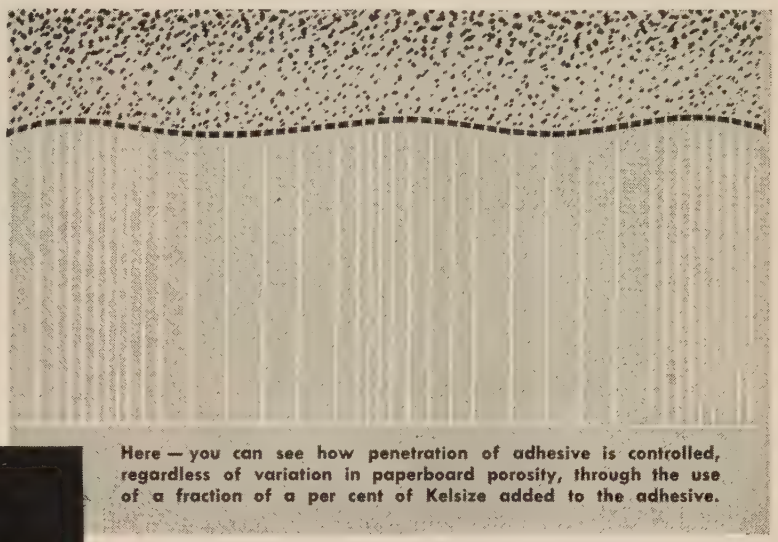
A question concerning the difference in coating a hot sheet in machine coating and a cold sheet in off-the-machine coating was referred to Mr. Case who described the Faber Coater in the now dismantled Time Magazine Coating Mill. This coater operated at 1100 feet per minute at a 600°F. drying

for UNIFORM PENETRATION

of adhesive in corrugated paperboard

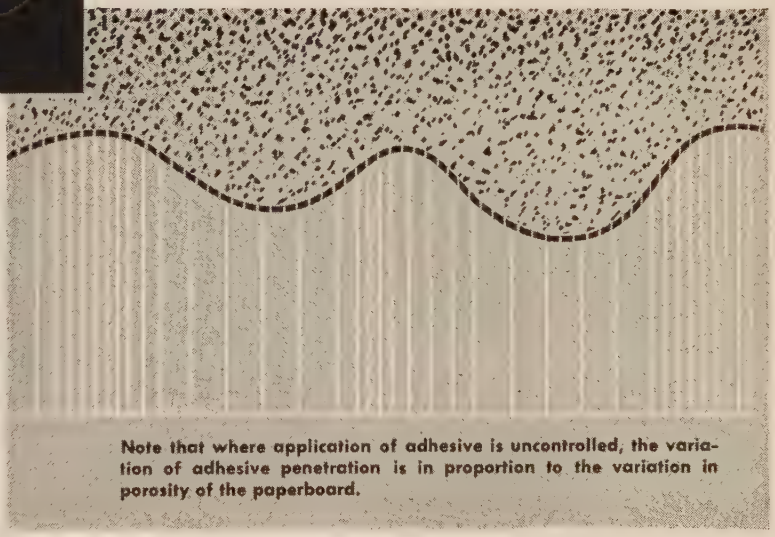
...USE

Kelsize



Here — you can see how penetration of adhesive is controlled, regardless of variation in paperboard porosity, through the use of a fraction of a per cent of Kelsize added to the adhesive.

Here are representative cross sections of a sheet of paperboard showing variation of both internal and surface porosity.



Note that where application of adhesive is uncontrolled, the variation of adhesive penetration is in proportion to the variation in porosity of the paperboard.

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temperature. The flash drying of a high solids coating resulted in an appreciably higher wax number than was obtained with the same base stock on air knife coaters with slower speeds, lower drying temperatures, and lower solids content of the coating color. Mr. Wilkins asked about the advisability of using a sheet with high ink receptivity for gloss ink printing. Mr. Kirkpatrick answered that a gloss ink sheet should be similar to a label paper for varnishing. Mr. Lagerpusch stated that the furnish of the base stock also has a great effect on gloss ink printing.

Mr. Luey and Mr. Rice reported an investigation which showed that an ink film splits at a constant ratio independent of the receptivity of the base stock, and that this ratio is close to 50-50. Other representatives of paper board mills confirmed these findings. On the other hand, representatives of book paper mills joined by Mr. Davidson contended that the amount of ink removed from the ink roller or blanket is a function of the ink receptivity of the coated sheet.

The above report covers only the high lights of the discussion which lasted two hours and was unusually vivid and pointed. Messrs. Kindig, Galbraith, Grimm, and Harrison participated constructively together with the other members of the panel in the discussion.

A. H. Nadelman and E. E. Stephenson

Delaware Valley

Chairman A. S. Erspamer welcomed those present at the March 22 meeting of the Delaware Valley Section.

Dr. Erspamer stated that the ballots for the election of officers for the 1951–1952 term will be mailed out shortly by Dr. Brill. Dr. Erspamer introduced Joe Paciello who wished to make a few announcements. Mr. Paciello announced that the Nominating Committee, consisting of himself, E. Albert and J. Macadam recommended the following ballot: Chairman, A. S. Erspamer; first Vice-Chairman, H. Brill; second Vice-Chairman, F. Lovegren; Treasurer, E. Padavic, and Secretary, D. Newcomb.

Dr. Erspamer then introduced the speaker of the evening, E. T. A. Coughlin, Chief of Paper and Paper Products Unit, Office of the Quartermaster General, whose topic was "Production and Procurement of Paper Items."

Mr. Coughlin has a wealth of experience in the paper industry and is one of the original charter members of TAPPI. He just recently left private industry to take over his present duties in the Office of the Quartermaster General.

A lengthy discussion period followed Mr. Coughlin's address. Theodore Kapala, Chief Technologist, Paper and Paper Products Unit, Philadelphia Quartermaster Depot, assisted Mr. Coughlin in answering some of the questions during the discussion.

Chairman Erspamer expresses his appreciation on behalf of the Section to Mr. Coughlin and Mr. Kapala and adjourned the meeting. The attendance was about 60.

Production and Procurement of Paper Items

E. T. A. COUGHLIN

Fellow Members of TAPPI, Delaware Section: Just about three weeks, ago, your very energetic Program Chairman, Mr. Haug of Scott Paper, managed by some unknown method to locate my telephone number in Washington. Not being quite sure that he had the right party he started off with, "We have heard about the fine speech you made at one of our other Sections and—" Of course, this opening was too good to pass up so I interrupted with, "Well! Well! TAPPI's grapevine has nothing on the F.B.I. This is pretty good billing for the speech I intend to give at the Ohio TAPPI Meeting next week, March 8." However, Mr. Haug was not to be confused, and said the Delaware Valley Section would be interested in the same presentation if I could arrange it.

In the Army, you know, you don't arrange anything yourself. Everything is arranged for you through channels. So, I advised him, if it met with the approval of my superior, Dr. Warren Stubblebine, Research Director of the Chemicals and Plastics Section, in the Office of the Quartermaster

E. T. A. Coughlin

General, I would be glad to take on this added task. Unfortunately, Dr. Stubblebine came into the office at that moment, and after switching the call to his office, he yelled out the door—"Hey Ed, do you want to give that same thing again in Philly?" Of course, I was delighted to say yes and so here I am.

The present Paper and Paper Products Unit, of the Research and Development Branch, is a new unit which has been set up with me as supervisor, in Washington, D. C., under the direction of Dr. Warren Stubblebine. This unit will operate with limited personnel stationed at the Philadelphia Quartermaster Depot, who will maintain a continuous program of paper materials evaluation. By no means is it intended that the Philadelphia Laboratory will conduct evaluations of every paper material manufactured, but it will be used for the evaluation of those items which have strictly military value.

After all these years, I have become acquainted with a new angle—"Military Characteristics must be considered in making paper for Military Use."

This necessity for special characteristics has been determined by constant hard usage, with attendant constant criticism of failure to perform under actual operations. Defects have been noted and changes in specifications have been made to correct these deficiencies.

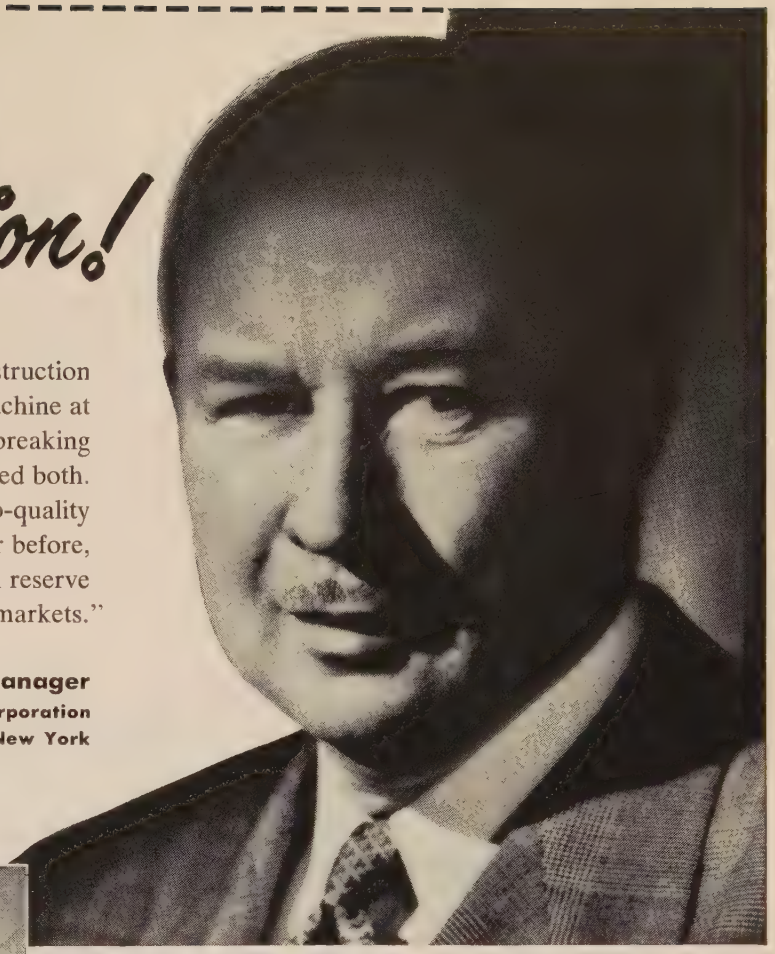
We have found that it is the policy of the Quartermaster Corps to base a specification for paper on a commercial product whenever possible. If it has been determined that the commercial product is not satisfactory, then the requirements for that item are changed. Occasionally, certain characteristics of a paper product are included for maintaining quality control. This quality control is desired for the protection of the Government. Whenever it is demonstrated that these requirements are superfluous any suggestions for the removal or alteration of these requirements will be given consideration. However, when these characteristics have military importance, then these requirements must be maintained.

The development of high-wet strength map papers is a particular instance of this procedure. Ordinary usage does not anticipate the use of a map in a downpour of rain, in subzero temperature, in steaming jungles or blistering deserts. Oily and greasy hands leave smudging marks that must be cleaned, erased, rubbed or washed off repeatedly.

Expansivity of this paper is a vital feature to control rigidly, not only for very close register or printing, but also for subsequent field use in calculating distances.

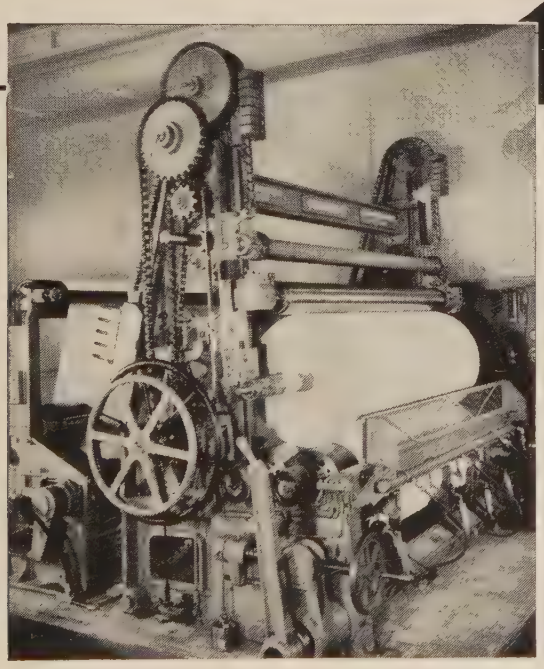
Resistance to abrasion or rupture either when wet or dry, has been made possible with high strength values, such as tear, fold, and tensile.

They emphasize *production!*



"When we were planning construction of our revolutionary new coating machine at Johnson City, N. Y., we asked for record-breaking capacity, and *reserve capacity*. We achieved both. We're producing and converting top-quality sensitized papers faster than ever before, and we still have plenty of capacity in reserve to meet new demands in expanding markets."

JAMES FORRESTAL, General Manager
OZALID, Division of GA&F Corporation
Johnson City, New York



The Camachine 14 at Ozalid is equipped with pneumatic constant web tension unwind, electronic side register control and pneumatic slitter units. Speed rated at 1800 f. p. m. Maximum rewound roll diameter is 38".

OZALID's giant paper sensitizing machine, largest and fastest in the world, is capable of coating and drying 249,000 feet of 79" web per eight-hour day. The 79" web is converted to standard width rolls on a Camachine Type 14 Slitter-Rewinder. Single shift operation of the Camachine handles the complete output of the coating machine, despite overtime scheduling of the coating operation. Camachine has substantially increased the Ozalid production potential over roll converting equipment formerly used.

Its reputation for dependable, trouble-free performance at record-breaking speeds has made Camachine the *one* outstanding name in roll production equipment. No matter what material you produce or convert in roll form, Camachine engineers will be pleased to consult with you regarding faster production and improved roll quality.

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All of these properties are noted in Federal Specification UU-P-361 and later amendments, and can be produced by careful manufacture, with the proper fiber composition and additives.

At present there is a critical demand for this item and the tonnage item will be increased, in direct proportion to the areas and forces involved in military operations.

Due to the limited tonnage of alpha pulps suitable for high-wet strength map papers, we can anticipate a growing problem of procurement. This is an opportunity for the paper mills in this valley, which have the technical skill, equipment, and experience, to produce this paper or to develop a new paper using fiber compositions which are more readily available, and which will also meet the rigid requirements for military uses.

This is a challenge that every wide-awake operator should like to meet. A large portion of the map paper procured is used by the Engineer Corps for military maps and they term them as a "blueprint of all phases of the military, from planning to operation." Whenever maps are lacking or inadequate, operations are severely handicapped.

To paraphrase the old adage "An Army Travels on its Stomach," we might add that it could not even move without paper. Paper is required in huge volumes to handle the many phases of operations. It is even difficult to list the various grades in the proper sequence of importance. They are all important from high-grade rag content bond to the low quality of newsprint.

Naturally, all of your mills in this area are interested in the grades of papers which you are currently producing. Unfortunately, I do not have the latest estimates of the tonnage required by the New York Procurement Office in this list of papers. Be assured, however, it is an appreciable quantity of adaptable grades, which will fit your paper machines and equipment. Such papers are as follows:

1. Rag content bonds, ledgers, manifold, index, blueprint, and drawing.
2. Sulphite bonds, writings, ledgers, manifold, and index.
3. Machine finish book, English finish book, supercalendered book, machine coated book.
4. Mimeograph, duplicator, blotting, and cover.
5. Offset, antique book, bristol, and tag.
6. Coated papers and basic papers for converter items.
7. Kraft wrapping and liner. For laminating and boards.
8. Folding carton, container, and corrugated.
9. Tissue, sanitary, toilet, toweling, napkin, absorbent wadding.

Each of these items will be required in increasing quantities in direct proportion to the degree and magnitude of mobilization. With few exceptions, every mill in this area can produce one or more of these items.

All of these papers are covered by a Federal or Military Specification. Since you have been advised by the Government to reserve 5 to 10% of your production for possible purchases by the various Government agencies, it would be advisable to provide yourselves with a copy of each specification for the particular paper which you can satisfactorily manufacture.

Speaking for the Office of the Quartermaster General, on paper requirements only, if you have not already done so, write to: New York Quartermaster Procurement Agency, 111 East 16th Street, New York 3, N. Y., requesting that the necessary application form for placement on lists of bidders be forwarded to you. Complete the form and return. A convenient booklet on "How to Do Business with the Quartermaster Corps" might be of service and of interest. It will be mailed to you upon request from the New York Procurement Agency.

If you can describe in a condensed statement on an index card (3 × 5) the particular grades you make, the daily tonnage, the maximum and minimum trim, weights, finishes, etc., this will be of service to our men in New York when special procurements are necessary. Also, individual cards (3 × 5) listing on the upper right-hand corner the grade of paper or board, etc., with the same basic information on sizes, weights, trims, finishes, colors, and qualities in lower lines. These data presented in this way can be quickly used to your advantage.

Although your interest is centered chiefly upon particular basic grades of paper, which have their own definite end uses, you may be requested, if hostilities increase, to furnish a paper which serves as a component in the end item. A few of these end items have been developed with rigid requirements for specific performance. In order to avoid a continuing series of sample runs with the usual failures or mediocre results, some of these papers have been confined to a selected list of proved and experienced converters. However, with the increasing tempo and activity, we can anticipate a condition wherein the enlarged requirements cannot be supplied by the usual converters or even by the paper mills which now furnish the basic stock.

One of these special converted end items is Paper, Teletype, Tape form, oil, perforator. It is supplied in small rolls, 0.687 and 0.875-inch widths, diameter 8 inches, for use on automatic high-speed teletype equipment. The message is produced in perforated form, with sharp, clean characters, which may be subsequently reproduced a number of times without distortion. It is obvious that this basic paper must be free from metallic particles, shives, holes, lumps, shiners, slime and size spots, etc. It should be uniform in weight, caliper, and formation. It should be free from ash and as nearly neutral pH as possible. The physical strength factors and fiber composition of this oiled tape are described in Federal Specification UU-P-547 as Type III (new specification in process).

In ordinary times, the annual consumption is in the range of 3000 tons and may be increased to 6000 tons or more. The production increase should be handled by new sources, and a definite quantity should be furnished by this Section. Again the technical skill, know-how, and papermaking facilities are right here, and the advantage of selecting a desirable paper for profitable manufacture should not be overlooked.

Perhaps the greatest volume of paper, or structures of paper components, used by the military is covered by the heading of Packaging and Packing. It is difficult to obtain exact data on the tonnage, but we understand an annual consumption of 1,000,000 tons with an estimated value of $250,000,000 was a conservative figure during the last war. We all appreciate the present cost of living is somewhat higher than that period, so we may expect the same ratio to apply. Consequently with the same degree of mobilization applying we might estimate a potential of 350 to 400 million dollars as an annual outlay.

A large portion of this amount is absorbed in kraft wrappings, plain and asphalt laminated; in containers, V and W boards, both solid and corrugated, in cartons of all sorts, in special interior barrier papers of various constructions. In the latter class, barrier papers, most of which are converter items, we encounter a wide range of combinations of papers, which include aluminum foil, plastic coatings, cloth, and film laminated materials. Each combination serves a definite purpose, and is representative of the vast amount of study, research, and ingenuity expended by the military and industry to meet exacting requirements under unusual conditions.

These barrier papers and materials must protect the enclosed item for an indefinite period—possibly a number of years—and maintain it in a satisfactory condition for the intended use. Protection of enclosed items are desired against gain or loss of moisture; whether stored at −60 or 150°F., and whether stored in exposed or enclosed areas. The protection must resist extreme conditions of handling—such as experienced in loading and unloading from factory to trucks, trains, ships, and planes. Isolated areas will require this protective wrapping to function when the package is dropped directly into the sea and floated ashore. Immersion in salt water may be as long as 24 hours.

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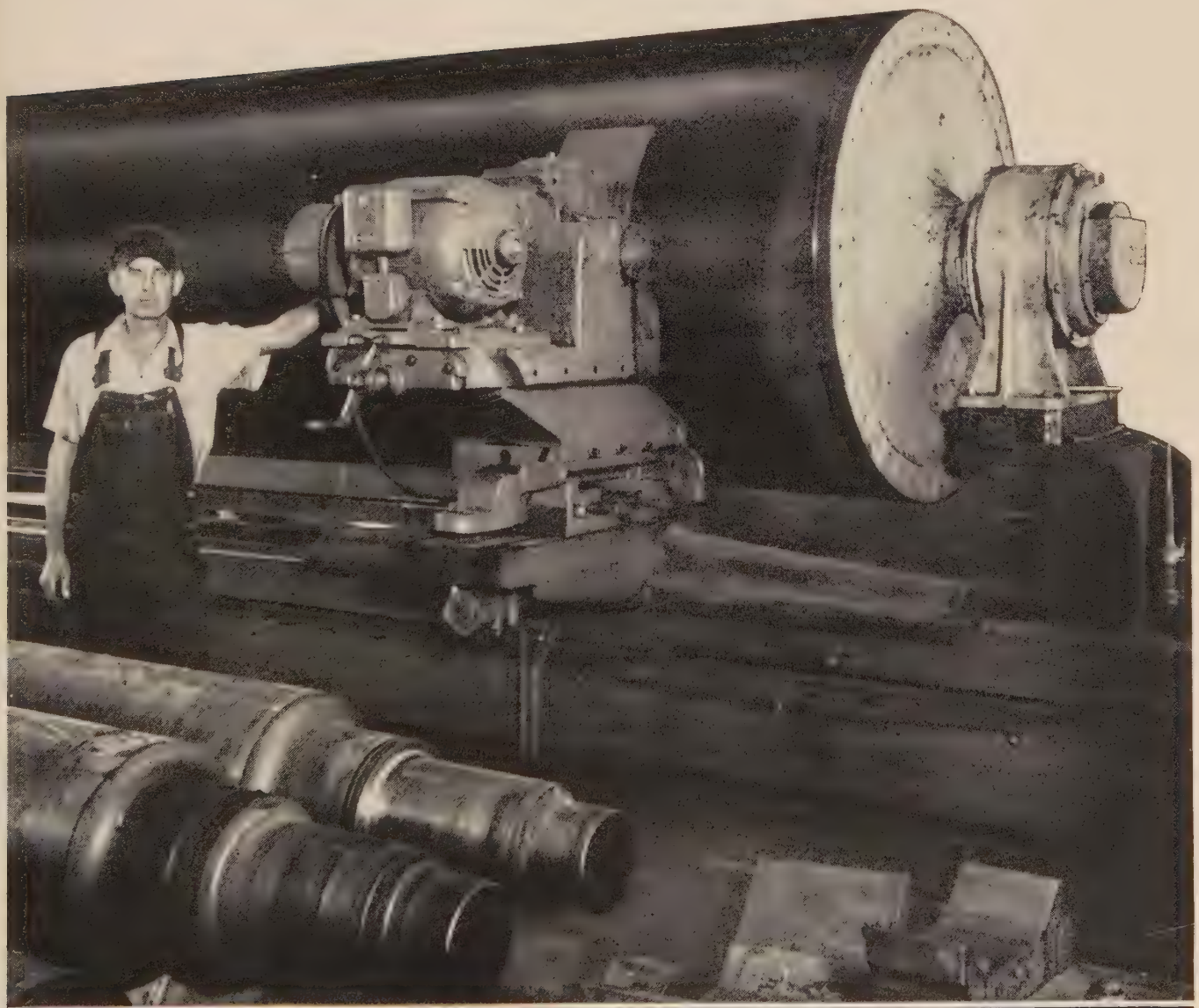

LOBDELL UNITED COMPANY
1836 WILMINGTON 99, DELAWARE 1951
A SUBSIDIARY OF UNITED ENGINEERING AND FOUNDRY COMPANY

The Quartermaster Corps, either directly or indirectly, are investigating the application of compounds to paper which will impart mildew resistance, insect repellency, and rodent repellency. At present, there is a requirement for an insect-resistant treatment which specifies the application of a uniform coating of a mixture of pyrethrins, piperonyl, butoxide, and suitable carriers and bonding agents to the exterior surface of the outside ply of a multiwall paper sack, as per JAN-P-118A.

Field tests on a considerable number of treatments showed this coating to offer the best results in protecting flour and other subsistence items from insect damage during storage. In the field test, the treated outer surface of the outer ply of a multiwall bag gave excellent protection when these bags were exposed to heavily infested conditions. Here, it is believed, the military agencies have taken the initiative, and industry will follow.

In the studies on rodent repellents, conducted by the Fish and Wildlife Service, under the sponsorship of the Office of the Quartermaster General, the repellent activity of more than 3000 chemicals has been determined. About 10% of these compounds possess notable degrees of repellent activity and offer promise of effectually reducing rodent damage to packaging materials. Application of the more active compounds to paperboard panels and cartons has produced significant decreases in evidence of gnawing by laboratory and wild rodents.

Plans are being made to apply the test compounds on the calender stack to the outer liner, and in the glue lines in the lamination of the board.

Many of these barrier papers and combined materials are produced in your area by a number of converters. Samples of a few of those end items are available here and may be of interest. The particular specification number, applying to each group of papers is plainly marked for your further reference.

For the past few months we have spent a considerable amount of time with representatives from mills and companies who are desirous of using their facilities in the interest of The Department of Defense and other Government agencies. A number of these conferences were mutually beneficial, particularly when the item under discussion was established or improved and had been thoroughly tested by the manufacturer, in accordance with a specification and supported by adequate performance data. However, a lot of time, effort, and expense could have been avoided if some of these representatives had a more complete knowledge of Quartermaster requirements and the specific manner of operation.

The Paper and Paper Products Unit of the Research and Development Branch of the Office of the Quartermaster General will welcome the opportunity of advising or assisting on any economical improvement in the various papers, if this can be accomplished without loss of any of the established military characteristics of the item.

We will possibly encounter occasions where an established component is listed as critical, or in short supply, or is given a priority for a more strategic use—at that time we plan to be ready to recommend or supply an adequate substitute. This field of research should be of interest to all of you present. It is not a new phase, for during the last war, most mills were faced with curtailed shipments of pulps and necessary chemicals and were still able to deliver satisfactory products.

For containers used in packaging you should contact the Chicago Quartermaster Purchasing Agency at 1819 West Pershing Road, Chicago 9, Ill.

In each of these offices you can see the papers or items in which you are interested; you will be advised on the exact or estimated current requirements and how this tonnage may be delivered in a regular and orderly manner.

DISCUSSION FOLLOWING MR. COUGHLIN'S ADDRESS

Question: If one is in doubt about the actual requirements of a specification, what should he do?

Mr. Coughlin: Some specifications are written to describe a product. There are admittedly some ambiguities in our specifications and when they occur, we try to have the specifications rewritten.

Mr. Kapala: If there is any doubt about the specification, contact your contracting officer and he will get the specification clarified.

Question: Are there any abstracts of specifications for the whole field of paper?

Mr. Coughlin: We have no abstracts, but we do have an index which may be obtained through the Superintendent of Documents. Specifications can be obtained from the Philadelphia Quartermaster.

Question: If a mill is handicapped in not having an effective routine control testing system, does your unit attempt to help such a mill to set up a system?

Mr. Coughlin: No, our unit does not. It is up to the mill to use its ingenuity to make the best of what they have. Statistical control methods would help such a mill in that it allows one to cut down the number of tests to an absolute minimum.

Question: If a mill does not have the proper materials to make a product fit the specifications, should it go back to the contracting officer?

Mr. Coughlin: By all means, yes. The contracting officer will definitely get an answer as to whether a certain specification or specifications can be waived. If the situation warrants it, the specifications in question most likely will be waived.

E. R. PADAVIK, *Secretary*

Chicago

"The Current Trends and Past History of the Paper Box Industry" was the subject of discussion by a panel at the dinner meeting of the Chicago Section held March 19, 1951, at the Chicago Bar Association, 29 South LaSalle Street, Chicago, Ill.

Edward C. Berg of Ace Carton Co., acting as moderator, introduced the panel members: Joe Kubicka, Container Corporation of America; Harry Wahn, Ace Carton Co., and John Redpath, Chicago Carton Co.

Boxboard

Mr. Kubicka's remarks follow:

A major trend in the boxboard industry has been the growing proportion of its output devoted to the production of board used in the fabrication of folding cartons. For the year of 1926, production of folding and setup grades was 1,341,300 tons; of this, folding represented 54% of the total. For the year 1949, production of both grades totaled 2,798,700 tons; the proportion of folding had risen to over 76%. Putting it in another manner, the tonnage of setup board has remained relatively level while the demand for folding stock has tripled.

To meet the growing demand, paper machine speeds have been steadily raised; at the same time, increasingly rigid specifications as regards uniformity, printability, and other physical qualities have been demanded through fabrication and use requirements. The development of high-speed printing, cutting, and gluing machinery, as well as parallel improvements in packaging equipment, has placed a premium on the uniformity of such board qualities as basis weight, caliper, rigidity, flatness, smoothness, ink receptivity, etc.

Progress in the production rate and quality of boxboard has been achieved through the work of many hands and minds—the mill operating and technical staffs, the machinery builders and their engineers, the manufacturers of felts, wires, rolls, control equipment—to name a few. Modern developments in boardmaking include such items as improved waste-paper defibering and cleaning equipment; more efficient fiber preparation machinery; consistency regulators to attain better uniformity in fiber-treatment and basis weight; suction press rolls; sectional drives; instruments for the measurement and control of such critical operating factors as roll nip pressures, sheet tension, drier steam pressure; felts which combine adequate strength and drawings with freedom from excessive sheet marking; equipment for smoothing and machine coating. The foregoing represents only a partial

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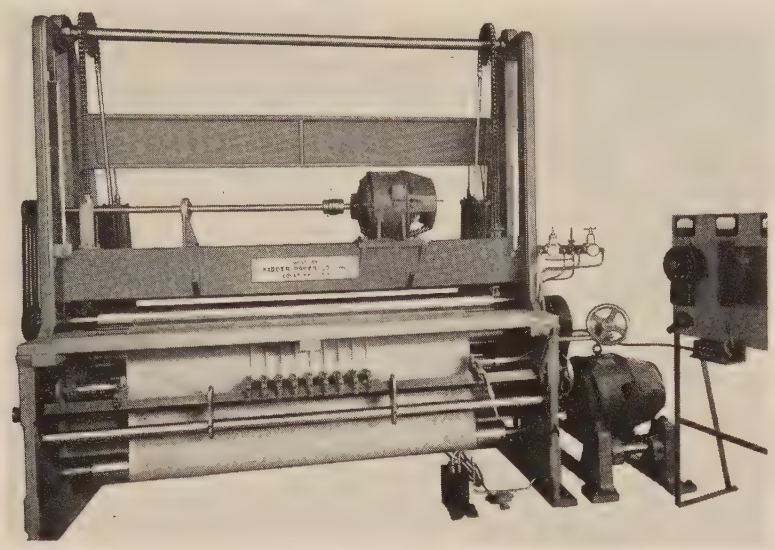

The **"JUNIOR"** "Mill Winder" available in 65", 74", 84", and 94" **trims.** Maximum Mill Roll and Rewind Roll diameters—50". Speeds up to 3000 Feet Per Minute. Minimum Slit—$1\frac{1}{2}$".

The **"MASTER"** "Mill Winder" available in 80", 90", 100", 110", 120", 130", 140", 150", 160" **trims.** Maximum Mill Roll and Rewind Roll diameters—60". Speeds up to 4000 Feet Per Minute. Minimum Slit—3".

Both of these machines are two-drum winders, each drum driven by separate motor, while rider roll is driven by auxiliary motor. Possible to wind hardest roll desirable. Ample capacity V-belts, easily replaceable, eliminating noisy gears. Water-cooled brake, rotating disc type. All-electric regenerative braking as complete drive unit, also available.

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"G. T."—similar in design to our "Mill Winders", especially built for handling gummed tape and counter rolls, etc., in 42", 54", 65", 74", 84", and 94" **trims.** Maximum Mill Roll diameter—40". Rewind Roll diameter—26"—special model 40". In speeds up to 1500 Feet Per Minute. Minimum Slit $1\frac{1}{2}$".

"JUNIOR" and "SENIOR" SUPER-SPEED Slitters and Rewinders—capable of handling from lightweight tissues to board stock, from 50" to 130" **trims;** and 40" and 50" Mill Roll and Rewind Roll diameters respectively. In speeds up to 3000 Feet Per Minute. Minimum Slit Junior Model—$1\frac{1}{2}$", Senior Model—4". These machines also supplied with similar equipment to the Mill Winders.

"C. W."—a center wind machine capable of handling a wide range of lightweight tissues to heavy tag stock, in 30", 42", 54", and 60" **trims.** Maximum Mill Roll and Rewind Roll diameters—36". In speeds up to 1500 Feet Per Minute. Minimum Slit—$1\frac{1}{2}$".

"MERCHANT"—capable of handling lightweight tissues up to heavier weight stock. This machine particularly designed for handling small Mill and Rewind Rolls. 30", 42", 54", and 65" **trims.** Maximum Mill Roll diameter—36". Rewind Roll diameter—26". In speeds up to 1200 Feet Per Minute. Standard minimum slits, $\frac{5}{8}$" on one cutter shaft, down to $\frac{1}{4}$" on three cutter shafts.

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H. W. Wahn, E. C. Berg, J. Redpath, J. Kubicka

list—a full account of papermaking improvements developed in the last 15 years would be lengthy indeed.

Returning to the original subject of this paper, boxboard, allotted time does not permit an exhaustive discussion of either setup or folding grades. However, since the latter types have commanded the greater interest, the bulk of the ensuing discussion will center around them.

Disregarding color and general appearance, the essential difference between setup and folding board lies in the part of the sheet known as the liner; in folding grades, the liner is required to withstand the stresses of the carton fabrication process without splitting or rupturing. This is accomplished through the proper mechanical treatment of fibers possessing the necessary inherent strength qualities. The fabrication stresses encountered will obviously vary with the caliper of the sheet and the type and size of the carton to be made from it. For example, the liner of an infold carton must necessarily possess greater toughness than that of a large paneled plain carton.

Since end use requirements vary within a wide range, numerous grades of board, both setup and folding, are available to the carton and box fabricator. If his requirements cannot be met through use of any of the so-called standard grades, it is usually possible for the mill to manufacture a product possessing the properties required to meet unusual specifications; these may require a modification of the formula or operating conditions to achieve such results as increased bursting, tear, rigidity, water penetration resistance, or changes in surface characteristics such as color, ink absorption, discoloration resistance, pick, etc.

Before proceeding to a description of the various grades of boxboard, it may be well to repeat the fact, known to every boxmaker, that there may be a considerable quality range in a given grade produced in various mills, different machines in the same mill, or even at different periods on the same machine. This is due to the large number of variables in materials, operation, and personnel which are constantly encountered in papermaking. Needless to state, the goal of every progressive mill is to eliminate or reduce these to a minimum.

The common grades of setup board are known as plain chip or chipboard, news vat, filled news, solid news, and white vat.

Plain chip is usually made as a two-stock sheet, the filler being formed of defibered mixed papers, the liner as a blend of somewhat stronger and cleaner waste fiber.

News vat differs from plain chip in that the top liner is formed of defibered newspapers; this affords a surface of greater color uniformity and cleanliness.

Filled news is produced with both top and bottom liners composed of defibered newspapers.

Solid news, as the name implies, is formed throughout of waste news fibers; its use is desirable when it is important that the filler be free of nonfibrous particles, such as would interfere with a satisfactory die cutting job.

White vat, made with either a chip or news filler, is a popular setup grade featuring a white liner. The liner is usually a blend of groundwood fibers (virgin or waste) and a light-colored, long-fibered stock.

Turning to the folding types, these will be described from the standpoint of their top liners, the characteristics of which

usually determine the grade name. The filler plies may be of news, mixed waste, kraft, and straw waste, or combinations of these; the specific filler materials used are chosen on the basis of availability and end use of the product. The bottom liner composition may also vary widely, or it may even be a duplication of the top liner.

The following thumbnail descriptions of some of the principal folding grades are necessarily brief, although the object has been to cover the main features.

Starting with consideration of some of the setup grades previously mentioned, specifically the chip and news grades, the strengthening of the liner or liners through the addition of suitable amounts of long-fibered stock results in their conversion to folding grades; these become known as bending chip or bending news vat lined chip.

Omitting the white lined folding types for the present, the colored grades in heaviest demand are the kraft and jute lined chips, mist fibered suitbox board in various shades, sulphite or kraft base lined stock in a wide range of strength and color. Generally, the liner color shade and depth forms the basis for the choice of either a kraft or sulphite furnish; for example a maroon board will usually be made with a dyed unbleached kraft liner, while a bright yellow color requires the dyeing of a sulphite base. The popular mist type of sheet achieves its appearance from the addition of a small proportion of black dyed kraft fiber to a sulphite base liner stock.

Turning to the white lined folding grades, the user's choice will depend to a very great extent on the type of printing job and the degree of whiteness or brightness desired. In order of price, brightness, and printability, and carton fabricator may select a manila, patent coated, super patent coated, or clay coated. The last-named is obtainable either as a machine-coated sheet or as the product of the older off-machine process. A general description of the foregoing types is as follows:

Manila. The liner of this grade is usually formed from an unbleached sulphite-groundwood base; the filler and bottom may be either chip or news. The shade can be varied through additions of tinting pigments.

Patent Coated. As compared to the manilas, this board is brighter and smoother. The liner is customarily a blend of bleached and unbleached sulphites, with a bleached soda pulp frequently added for improvement in brightness and opacity. Substantial amounts of clay and starch are also added to the liner furnish to help "close up" the sheet, thus improving the printability. This grade undergoes heavy calendering to obtain the maximum possible smoothness; for this reason, a smooth and well-formed filler stock, usually news, is a necessity.

Super Patent Coated. Patent coated of higher brightness, this being the net result of increasing the amount of bleached pulp in the liner and addition of pigments, such as titanium dioxide.

Machine Clay Coated. This grade is a comparatively recent development, making possible the advantages of a mineral printing surface at a cost well under that of the older types of coated stock. While the coat weight is roughly half of that applied by an off-machine coater, the resulting effect makes this type of board very satisfactory for many high-quality printing operations. As indicated by the name, the sheet is coated during the drying process by one or more coating stations located in the drier section.

Clay Coated. Stock is coated by this process after fabrication on the paper machine. The high coat weight possible with the brush or blade type of coater, plus the necessary supercalendering, result in a product which is considered by many printers as superior to machine coated.

Numerous other boxboard grades are available for special purposes, but a description of these would be outside of the limited scope of this paper. An attempt will be made to answer any specific questions during the period following the formal presentations.

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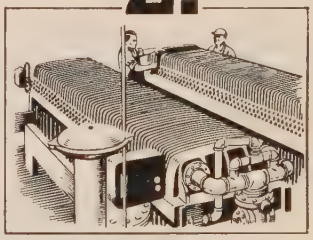
2.



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TECHNICAL DATA on both the above uses of Dicalite materials will be sent on request. A Dicalite Engineer will gladly be of any additional service possible.

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One of the most serious problems facing the paperboard manufacturer at the present time is the steadily increasing difficulty in obtaining an adequate supply of virgin fiber. With demand for pulp far outstripping supply, a hectic market condition has developed wherein pulps of any quality—good, bad, indifferent—are eagerly sought. Bad as it now may be, the situation is almost certain to get far worse in the not-too-distant future; among the reasons for this prediction may be mentioned the following:

1. A developing shortage of sulphur, a basic chemical used in the manufacture of sulphite pulps and sulphate.
2. An increasing tightness of the chlorine supply, which will be felt by the manufacturer of bleached and semibleached pulps.
3. Heavy European requirements which will place a drain of unknown amount on our domestic supply.
4. Eagerness of foreign purchasers to pay far over the domestic ceiling prices permitted by present Government controls.
5. Military requirements for purified pulp.

Under these conditions, the board mills are being forced to reduce the proportion of pulps in their folding grades and to increasingly rely on making up the deficiencies through the use of so-called "pulp substitutes."

At their best, these pulp substitutes represent the cream of the wastepaper stocks; they comprise trimmings and waste in the conversion of sulphite or kraft papers and boards into such items as envelopes, folders, cartons, etc. If care is exercised in the collection and segregation of these various types of wastepapers, a fairly satisfactory material for the extension of pulp becomes available.

However, to complicate the picture, an increasing number of mills engaged in the production of the papers mentioned are insisting upon the return (to them) of all scrap resulting from the fabrication process. Thus, they are able to extend their own pulp supply through the incorporation of the returned scrap into their manufacturing process.

Under present conditions, a scramble is taking place for the available tonnage of almost any type of waste that conceivably can be used to stretch out a dwindling supply of pulp. In such a market, considerations of fiber strength, uniformity of color and shade, cleanliness, etc., become of secondary importance. All this adds up to increasing difficulty encountered by the board mill in maintaining past standards of strength, color, brightness, cleanliness, and uniformity of its grades.

Printing and Cutting in the Folding Box Industry

The following is the presentation by Harry W. Wahn of the Ace Carton Co., Chicago:

Although actual printing in the folding box industry is but one of several operations which must be completed in the production of folding boxes, it is of great importance. To the extent that printing has had much to do with the development of our industry as we know it today, a few brief comments on the history of printing in general will serve to highlight major developments and their importance to our industry.

Using carved wood blocks, the Chinese were printing on paper as far back as 105 A.D. It wasn't until the 15th Century that the next major step forward was made with the invention of cast lead type by Guttenberg—generally acknowledged as the Father of movable type.

The first printing press came to America from England in 1638, but the next event of real importance didn't occur until the middle of the 18th Century, when Wilhelm Haas of Switzerland made the first cast iron presses and made it possible to manufacture printing presses in greater numbers and at lower costs.

Presses produced during the 18th Century and bearing such names as Stanhope, Columbia, and Washington were all hand presses. When Frederich Koenig of Saxony invented the cylinder press in 1814, greatly increased production speed and

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consequent reduction in costs really bridged the gap between the earlier handicraft type of printing and of industry we have today.

Compared with the long history of actual printing, the history of the folding box industry is short. An oath for a patent dated April 10, 1879, by Robert Gair, marks the beginning of the folding box industry.

At first folding boxes were intended to merely protect their contents against damage. In the "Cracker Barrel" days, almost every item sold was handled in bulk. The old fashioned grocery store may bring back pleasant memories, but they can hardly be remembered as pinnacles of sanitation.

Because the earliest folding boxes were designed purely from the standpoint of protection, or sometimes for convenience in handling, such as in the case of carpet tacks, printing of these boxes was not considered as too important. Many boxes were used without any printing at all, and even today, a large quantity of folding boxes are made without printing. These boxes have a place in the industry, but tonight, we'll limit our discussion to the manufacture of printed folding boxes.

Folding boxes made early in the 19th Century carried just enough printing to identify the contents, and sometimes not very well at that. As a rule they were printed in one and sometimes in two colors, employing type and occasionally a reverse cut. The board then used, as compared with today's standards, was of poor quality with rough surfaces and only fair bending qualities. The things the boxmaker could do with this type of stock were limited and, as a consequence, so was the quality of the finished boxes.

The use of these comparatively crude boxes did, however, help establish product identity and brand names. As more and more customers came to look for the familiar box bearing their favorite products, the manufacturers of these products came to realize that their packages in themselves could become valuable selling tools. Each strove to outdo the other in designing better and better boxes for his products to attract more and more customers. "Eye Appeal" became increasingly important in the race to gain product recognition on the dealer's shelves. In a relatively short space of time, the once plain folding box revolutionized merchandising methods and made possible national merchandising and distribution as we know it today. The folding box has become the greatest point-of-sale advertising force in the history of marketing.

In the race for more and more attractive packages, a great deal of pressure was brought to bear upon the boxmaker. He was constantly called upon to improve his product to meet new demands. The way in which this challenge has been met and problems solved is, in itself, a tribute to the folding box industry. It is essentially the quality of the printing which determines the "eye appeal" of the box, and, therefore, printing is of obvious importance to the industry.

Various printing processes and methods are used in making folding boxes. The most important of these is letterpress—the oldest form of mechanical printing known. It is estimated that as much as 70% of all printing done in the folding box industry is done by letterpress. It is a relief process by which the raised surfaces of the plates are inked and this ink applied directly to the board by pressure.

The typical cylinder press in use today is probably a familiar machine to almost everyone. They are available for single or multicolor work and in many sizes and kinds. Each has its own advantages and proper uses. Most letterpresses now in use in the industry are of the flat bed cylinder type. However, quite a few rotary presses have now been installed and are proving popular due to increased speed.

In printing an actual box, original plates are first made from finished art work. Electrotype duplicates are then made from these original plates, and are then placed on the press for the actual printing operation. These electrotypes can be made

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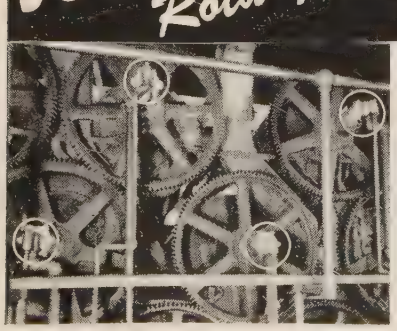

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of copper or nickel shells, depending upon the length of the run and the degree to which long plate life will be important.

We must also select the proper type and match the color of ink for the job. Inks with an oil-varnish base are usually used when a varnish overprint is to follow. The overprint varnish serves to enhance the colors of the inks and also to give a relatively scratchproof surface which is less apt to show finger marks, dust, etc.

Nonscratch inks are also used. They are made from synthetic varnishes and dry very hard, so that they are able to resist scratching and scuffing.

Gloss inks are used to approximate the glossy appearance of overprint varnish but with the saving of one impression on the press and with a resultant savings in cost. This type of ink doesn't offer any protection to the white surface of the box as does overprint varnish.

All of these inks dry through oxidation and require from 3 to 6 hours drying time. Continuous attempts are being made to develop inks which will dry at a much faster rate. Heat-set inks, however, have not as yet found a ready acceptance in the industry due to other problems in connection with their use. For one thing, the surfaces of these inks are not hard enough to resist marring during subsequent operations.

Steam-set inks will set as soon as steam hits the ink, but the applicators used have a tendency to throw water on the sheet leaving spots. In some cases, steam-set inks are being used satisfactorily even without the application of steam. Without steam this ink will dry hard enough to handle in about an hour, but when completely dried will not be sufficiently scratchproof for many uses.

Offset printing is also used in the folding box industry. In this process the board does not come into direct contact with the plate itself. The grained plate, on which the image or subject to be printed has been etched slightly below the surface, is run in conjunction with a water-acid solution and ink. The water and the ink will not mix. The grain surface of the plate holds the water and repels the ink. The image repels the water and holds the ink. The ink is transferred by a very light impression to a smooth rubber-blanketed cylinder which, in turn, comes into contact with the board, and transfers the ink to it.

Offset will print fine halftone screens on fairly rough surfaced board and deliver quality which could not be matched by letterpress printing on similar stock. Offset printing presses also operate at higher speeds than letterpresses. With this process there is a saving in plate costs and make-ready time.

Rotogravure, a relative newcomer, is a process by which the design to be reproduced is etched into a copper-plated cylinder which can later be chrome plated, if the length of run makes it practical to do so. The depth of etching determines the amount of ink that is applied to the board. The cylinder is run in a bath of ink. A scraper blade removes all the ink from the surface of the cylinder, leaving ink wherever the cylinder has been etched in. As the cylinder comes into contact with the board, this ink is transferred to the board. As the board runs through a heat chamber, the ink, being very volatile, dries instantly. These presses can be set up in sections to print as many colors as are desired. Most rotogravure presses are web fed and run at an even higher speed than offset presses.

Rotogravure presses, in the folding box industry, are sometimes equipped with rotary dies so that the box blanks are cut right along with the printing as a continuous high-speed operation. This is limited, however, to extremely long runs because of the very high cost of rotary cutting dies.

In the majority of cases, box blanks are formed during a separate operation known as "cutting and creasing." The dies are made very accurately and are locked in a steel chase which is put on a cylinder press similar to a one-color printing press, but without rollers, ink fountains, etc. On smaller jobs, platen presses are usually used.

The typical die consists of a number of cutting and scoring rules, spaced with plywood or steel blocks to form the panels, tucks, and flaps of the box. The cutting rules cut the blanks to shape and the scoring rules add the creases for bending. In a typical setup using a cylinder press, the dies are locked in the bed of the press. A "counter" of tough board is then glued to the steel jacket of the cylinder and grooves are cut to form a female die for the scoring rules. The counter is removed every place the cutting knife strikes the jacket. In operation, as the board feeds through the press, the cutting rules shape the box and the scoring rules push the board into the female die to form creases along the lines where the board will bend.

After the job has been completely made ready, it is necessary to put nicks into the cutting knives, so that they won't cut all the way through in a number of places. This holds the sheet together through the cutting press. These nicks, which are put in with a grinder or a chisel, are naturally kept as small as possible.

If the blanks are to be later stripped with an air hammer, more care must be used in placing the nicks than is the case when hand-stripping is to be done. Those responsible for cutting and creasing operations must work very closely with the stripping department to assure smooth operation.

In making small boxes, it is sometimes desirable to use cut scores instead of creases. In such cases, all rules in the die have cutting edges, only those intended to form cut scores are approximately half the thickness of the board lower than the actual cutting edges. Cut scores, cut about halfway through the stock, relieve stress on the corners of the box and allow the box to be set up easily and with squarer corners.

When the boxes are to be filled by automatic machinery, the die must be very accurate and perfectly square. At the Ace Carton Co., we follow the practice of numbering each individual die. We then run about a hundred samples from each die in advance and have them checked with the filling equipment to be used. We can then make corrections wherever needed.

To illustrate the importance of accuracy in producing boxes for machine filling, tucks must be most accurate. If they are too loose, they will not stay in position after running through the filling machine. If they are too tight, they will be crimped by the machine.

The type of board also is important. It can be too stiff or not stiff enough depending upon the use to which it is put. The filling machinery cannot compensate for too wide a variation in the box. Naturally when boxes are to be hand-filled, this is not quite so critical.

There are hundreds of other things to consider in the printing, cutting, and creasing operations necessary in the folding box industry.

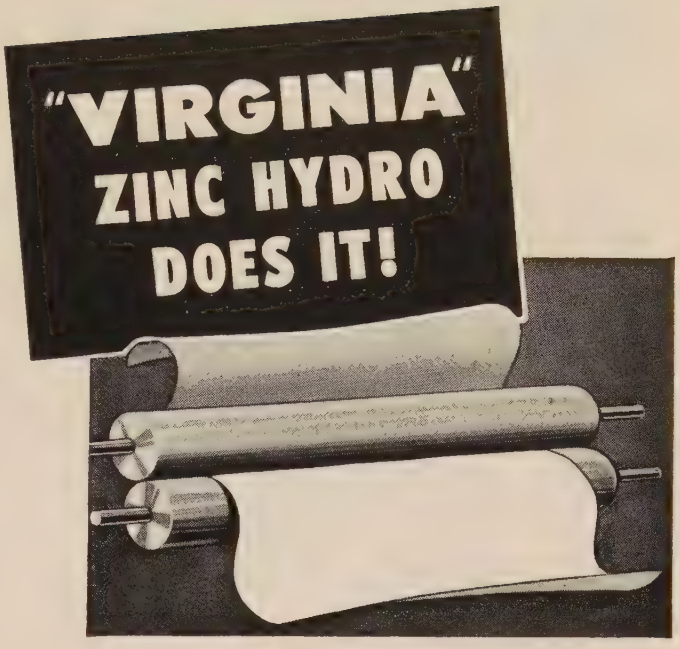
This has been a rough and very brief discussion at best and has been aimed primarily at establishing the basic factors in producing the high-quality folding boxes of which our industry is justly proud.

Finishing, Handling, and Production Methods

John Redpath of the Chicago Carton Co. made the following remarks:

The basic development of the carton industry had evolved from the development of two pieces of equipment used in the industry, namely: the cutter and creasing press and the automatic folder and gluer. Without this development of these two pieces of equipment, there would be no such industry as we know it today and following this development of the folding paper box a major change in the technique of retail distribution of merchandise the world over has occurred.

For instance, few packaged items appeared on the shelves of stores in the 1800's—most foods and goods were sold from bulk—customers carrying them home in paper bags. By 1910 unit packages had come into their own but bulk goods had still not passed from the scene. Today the packaging of



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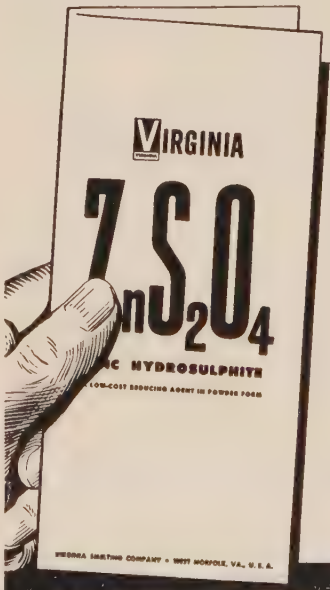

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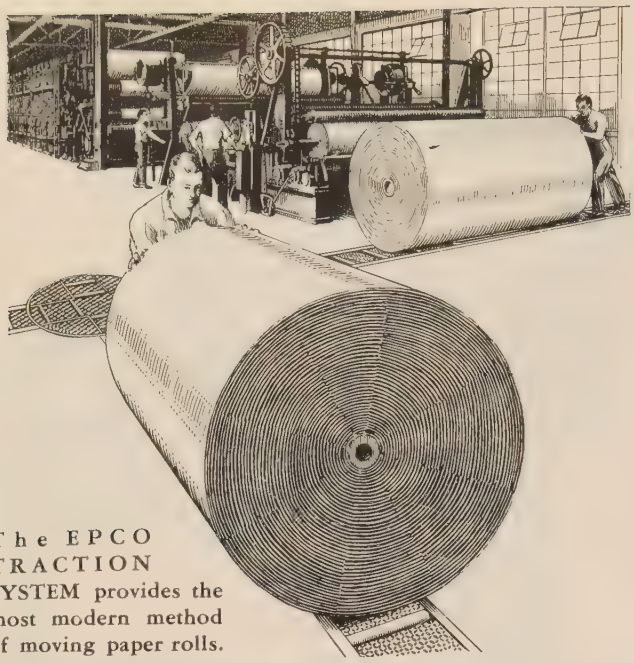

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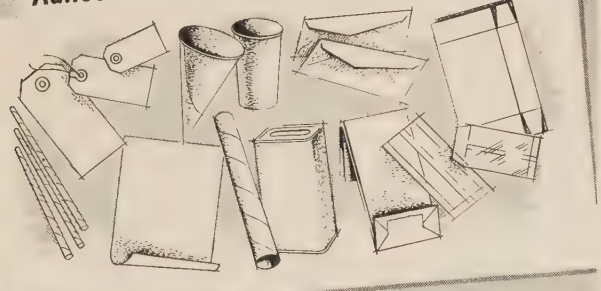

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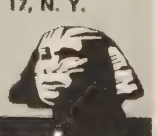

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goods is relatively complete as evidenced by a tour of your neighborhood supermarket.

Let's go back into history and see just what these major developments were that started us on our way to the point at which we are today.

In 1839 Col. Andrew Dennison started making boxes in his home in Brunswick, Me., with the aid of a cobbler's bench and a shoe knife cutting out setup paper box blanks with his daughters finishing the boxes after he cut the blanks.

Col. Dennison produced a corner cutting machine in 1844 which eliminated the hand cutting of corners and started a new era in box manufacturing which has not yet stopped.

The next great development and the greatest one upon which this industry developed was the invention of the cutting and creasing process by Robert Gair in 1879, in which he converted an Aldine Press to cutting and creasing. This press utilized one basic technique that today still remains unchanged in carton production, in which cutting knives and creasing rules are made into dies outlining the shape of the carton blank and locked into chases. This original press could cut blanks at the rate of 750 sheets per hour with as many as ten units on the sheet.

Still in these early days the seams of the cartons were stitched and later hand-glued, but by 1895 an automatic gluer was developed and the first automatic gluer and folder was in use by 1904 gluing and folding cartons at the rate of 150 per minute.

In 1905 the E. G. Staude Manufacturing Co. brought out an automatically fed gluer and folder with a counting device, and in 1912 the International Paper Box Machine Co. developed a paraffining machine.

With these developments we were on our way to the industry as it is today.

Subsequent developments in machinery, materials, and plant layouts have been all toward one end—to make better cartons in greater quantities, more efficiently, and at lesser cost.

To give you an idea as to the productivity of a plant in the late 1800's, as compared to a large-sized modern one, a foremost plant then turned out 20,000 boxes per day with 200 workers, compared to a large plant today turning out 5,000,000 boxes per day with 500 workers.

What has achieved this? Basically, newer, better, bigger, and faster equipment, but of the same old tried and proved techniques of years ago. The work horse of the industry is the flat bed cylinder letterpress, printing press, and the flat bed cylinder cutting press, taking large size sheets of paperboard. These presses are readily adapted to quick change of jobs and can print or cut any type or size of folding box that is practical to make. They will take a sheet size approximately 46 × 70 inches and run at speeds of 1200 to 2000 sheets per hour. Supplementing this basic equipment are printing presses capable of running 5000 sheets per hour with four and five colors, or again printing presses capable of running paperboard in web form at even higher speeds. Again the same supplemental developments have occurred with cutting presses. We now have workable automatic carton blank stripping devices which can be attached to standard cutting and creasing presses, which in most instances strip away all the wastage only leaving the carton blank to be broken up with the aid of pneumatic air hammers especially adapted for the job.

We have automatic cutting and creasing of paperboard in web form, the web being printed or unprinted at speeds of from 100 to 300 impressions per minute. The blanks further being automatically stripped and delivered on a conveyor belt. Such machines are usually specialty machines constructed for specific types of cartons.

Again our automatic gluing and folding machines are built to produce a variety of types of cartons at high speed. It is a far cry from the first automatic gluer producing 150 cartons per minute to that of today, producing anywhere from 200

per minute to 2000 per minute at belt speeds up to 1200 feet per minute.

Specialty gluers will produce up to 24,000 cartons per hour, gluing many cartons you see in everyday use, such as bakery trays and small parts boxes which are opened by the flick of a hand. One of these machines will now produce more cartons in an hour than a whole factory could in 1 day, 50 years ago.

Along with this, in order to handle this volume of material, equipment familiar to all industry such as electric fork trucks, electric cranes, skids, pallets, and conveyors are necessary.

This is the picture of the development and trend in the folding box industry, a familiar picture of American enterprise which started out with a cobbler's bench 100 years ago and is now a necessity to our way of life.

1. History of the Industry.
   (a) Basis of Development of the Industry.
      (1) Cutter and Creaser.
      (2) Automatic Gluer.
   (b) Significant Developments of Equipment.
      (1) 1839—Cobblers Bench—Col. Andrew Dennison.
      (2) 1844—Corner Cutter—Col. Andrew Dennison.
      (3) 1879—Cutter and Creaser—Aldine Press—Robert Gair—750 per hour—10 up.
      (4) 1895—Automatic Gluer—Munson Plant.
      (5) 1904—Automatic Gluer and Folder—150 feet per minute.
      (6) 1905—Automatic Gluer, Folder, and Counter—E. G. Staude.
      (7) First Cutter and Creasers Converted Printing Presses.
      (8) 1912—Paraffining Machines by International Paper Box Machine Co.
      (9) 1939—Air Hammer Stripping.
      (10) 1949—Rotogravure Sheet Fed Printing on Paperboard.
      (11) 1949—Automatic Stripping Device by Miehle.
      (12) 1950—Continuous Web Printing, Cutting.

Questions and Answers

Question: Is there a formula used by the trade whereby the amount of drag on a drag lock infold carton can be determined by the degree of angle of the diagonal crease? Where should the diagonal score begin in relation to the corner of the carton where the score rules meet?

Answer: The diagonal score should form angles of 44 and 46° with the slot and side score, respectively. To get drag on lock corner, the drag lock should line up with the center of the end score. (*Note:* A sample carton was presented to illustrate.) The three scores should meet in the center—the diagonal score should meet where the end and side scores come together.

Question: In your opinion, what is the ideal moisture content of chip to be used in single and double sheet lined boxboard; and the moisture content of the finished lined sheets? To what extent does moisture content of chip influence curl and warpage of finished lined sheets?

Answer: Very difficult to answer; desirable moisture content depends on many factors. Moisture content has a very important influence on curl of lined board. Board is not dimensionally stable, and if its equilibrium content at certain air conditions is $x\%$ and the board has a higher content, it will lose moisture and curl, particularly in the cross direction.

Question: In laboratory control of folding boxboards, are any tests conducted to determine the adhesive receptivity of the board before it is delivered to a carton manufacturer?

Answer: Assuming the question relates to water soluble adhesives such as dextrines, the test generally used is one indicating the resistance of the board surface to water penetration, for example the Abrams No. or the water drop test. The tests are not too good, but it is known that if the test value is above a certain level, trouble with the adhesive taking to the board results.

Question: Considering the facts that offset printing affords higher speed printing, cleaner, finer printing, and lower plate costs, why isn't this type of printing more widely used in printing cartons?

Answer: Each printing process has its place in the folding box industry. The offset can screen better on rough board than letterpress. Offset is the coming process, but it is more touchy and this fact is probably the main reason it is not used more at present.

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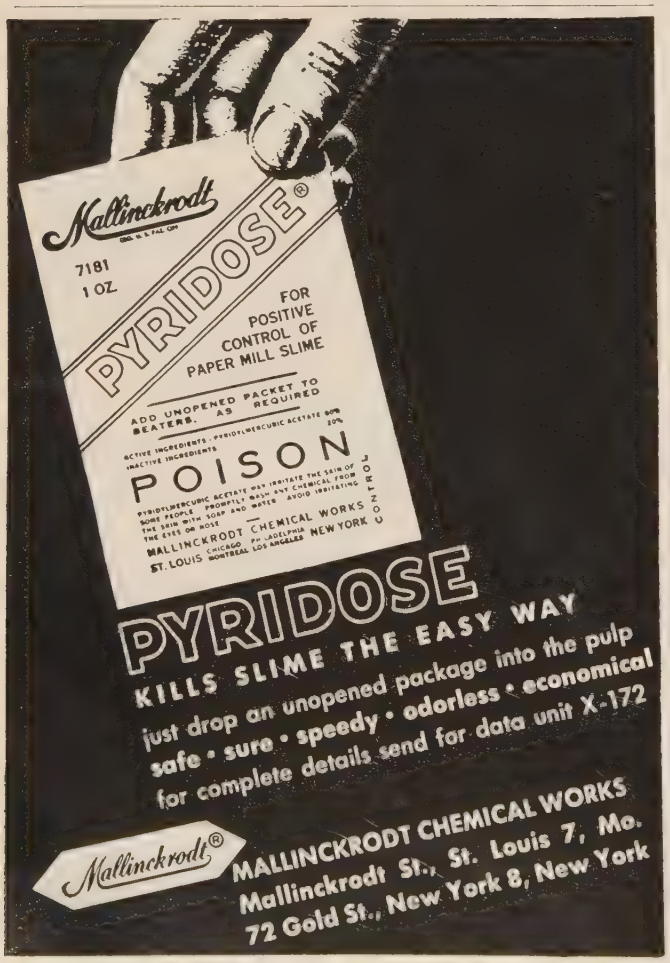
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Lake Erie

February Meeting

On Friday evening, February 16, Robert Belt, Merchandising Equipment Executive of the American Greeting Publishers, Cleveland, Ohio, addressed forty members of the Lake Erie Papermaker's and Converter's Association on the subject of "Materials Handling."

Mr. Belt discussed materials handling problems and their solutions and supplemented his remarks by showing a film entitled "Cost Reduction Through Materials Handling."

Lost production through overcrowding of processing and warehouse space and lack of proper materials flow prompted many questions during the discussion period.

Mr. Belt's remarks follows:

Right here, and now, I'm going to charge everyone in this room for being an accessory to the fact in the perpetration of a crime. The crime is permitting ineffective, inefficient material handling methods to continue in the plants where you work, or which you serve. Every day you pass an inefficient material handling operation with no thought of its effect on the costs of production. You see improper equipment, poorly maintained, improperly used; you see material moved by high-priced production employees, leaving their high-priced machines idle; you will find equipment designed for an operation of 20 years ago trying to produce a new product at a rate for which it was not intended; you will find men doing a job that can be performed far better by a mechanical device.

While Management is responsible for permitting these conditions to persist, Management cannot and should not be held entirely accountable for their creation.

The past 15 or 20 years have drastically altered the complexion of American industry. Our markets have expanded; the products from almost any given company have changed; new materials have been developed which made these new products possible; science has truly changed the face of America. Along with these innovations has come more aggressive competition, and this, in turn, has necessitated improved methods of manufacturing. We are all prone to follow the line of least resistance, if given a choice, and Management is not much different than the masses in that respect. Consequently, the direct operations received all the attention of Management, industrial engineers, and cost accountants for many years, leaving such functions as maintenance and material handling to shift for themselves.

Now, Management has reached the point of needing to reduce material handling expense because of rising labor, material, and other operating costs, but finds itself in the embarrassing position of not knowing what its present material handling bill is. In fact, in many cases these costs are so thoroughly buried that the Cost Department has no idea where to look for them. To accurately pinpoint material handling expense, in a number of companies with which I am familiar, a complete revision of cost-finding methods was necessary. In our own company, we, in the Industrial Engineering Department, found it necessary to use our own methods of obtaining such costs because the Cost Department was undergoing a reorganization, and to wait would have been harmful to the company. Let me emphasize in passing, however, that expedients should not take the place of sound cost data. Knowing what the cost items are, and where they may be found, is an absolute "must" to do a good job of reducing costs.

Material handling costs are usually found buried in production costs, or in shipping, storage, or packing. A recent survey conducted by *Modern Industry* showed that ten items, including handling, packing, receiving, warehousing, shipping, insurance, and maintenance, among others, were lumped together under two headings—plain warehousing or plain transportation. This was from the majority of the 1500 companies included in the survey. How can you determine, by this method of cost accounting, whether your handling costs are good or bad? How can you put your finger on a specific inefficient operation? It is my firm conviction that handling costs are far too important and too great to continue to be ignored.

The Material Handling Institute recently published a report which states that our annual national industrial material handling bill has passed the two billion dollar mark. Do you know how much money that is? Did you ever stop to think of it? If you had been saving a thousand dollars a day since 3400 years before the birth of Christ, you still would not have two billion dollars.

In addition to telling us how much we spend for material handling each year (and the cost is getting proportionately less each year), the Material Handling Institute also said that fully one third of that two billion dollars could be saved.

Now, at last, we come to the place where, according to the subject of this talk, I come in. How do we save this money? What is the formula? Unfortunately, there is no formula which can be applied across the board from industry to industry and from plant to plant. Each treatment must be tailor-made.

However, there are some basic principles which must be applied, regardless of the kind of business you are in, or the size of the operation. And they *are* basic, and easy to remember. Here they are:

Program. First you must have a program and that program must be preplanned. That sounds trite, but believe me too many people ignore it. I have seen many companies peck away like a sparrow at a watermelon, at various segments of what should and could have been a sensational program, only to have it die a quick and unnatural death.

Cost Data. As I have emphasized earlier, to know where to reduce costs, and to know if and how much you *have* reduced them, it is necessary to know from where you started. In other words, you *should* have complete cost data.

Man Power. Here is a source of vast savings. And because it *is* labor, it will undoubtedly receive the first attention from Management, and rightly so. The most precious possession of American industry today is not gigantic plants, nor expensive complicated automatic machinery, but it's man power—the men and women who operate the machinery, and make it possible to keep the plants busy. And the way this is being wasted in handling operations is inexcusable.

A few weeks ago I was in a modern, highly mechanized brewery and was pleased to see such a wonderful job of material handling when suddenly, like a sock on the jaw, I saw one conveyor end and other begin, at right angles to one another. And what do you think was happening? You guessed it. A man was sitting on an empty beer case manually turning each full case from one conveyor to the other. I asked my host about it, expecting to hear it was a temporary condition while a mechanical device was being repaired. Instead, he said: "I asked the same question 7 or 8 years ago and was told it was only 2 or 3 days a week that this fellow was needed so they did nothing about it."

Now let's suppose it *were* 2 days a week, and the man was paid $1.00 per hour. In seven years that man would have been paid $5824 for doing a job which could have been mechanized for less than $100. And he was probably doing the job much longer than 7 years.

Equipment. There have been so many advancements in the design of material handling equipment during the past decade that even many progressive companies are hard put to keep abreast of the improvements. The important thing is to make a thorough study of your needs in light of the job to be done; find out what equipment is best suited to that job, then buy it and reap the benefits. When something better is put on the market, the task is simple arithmetic to know whether it will be a good buy or not.

In the plant of the "X" company in Detroit, a few years ago, I was making an engineering survey which included, as an afterthought on the part of Management, material handling. They were using a system of tractor and wagon trains to transport material from one department to another. There were many modern methods which would both reduce cost and increase production, such as large volume electric transfer cars, overhead cranes, etc. Guess what they said when it was pointed out to them! Something to the effect that "the present equipment is not yet amortized."

Plant Layout. Here is a phase of the material handling program which makes many management people shy away from the whole thing. I don't know why so many men in management are afraid to move something. I don't propose that it be carried to extreme, like in the case of a company where changes in layout took place every day—continually and without apparent plan. A new employee seeking a certain plant office asked a foreman where it could be found. The foreman, with a look of despair, said: "I don't know, but if you stand still awhile it will be along shortly." On the other hand, don't do like Company "Y" of Grand Rapids. They had a series of pickling and washing tanks for cleaning steel, and I learned that because of location of two of the five tanks, the crane ran up 70% more mileage than necessary. I asked the General Manager how it happened. He investigated and came back with, "We had to do it this way because of the sewer layout." He carried the investigation further and turned up some remarkable facts. A change in the layout would cost about $3200, but the increase in production time because of the shorter travel, plus the savings in crane operating and maintenance costs, would pay for the move in less than 5 months. They relocated the tanks.

But, you are probably saying, "How does this affect me? I'm in the paper business." It affects you and your company the same way it affected the people and companies involved in these examples.

Let me tell you a little bit about our company, American Greeting Publishers, and our handling problems. We are the

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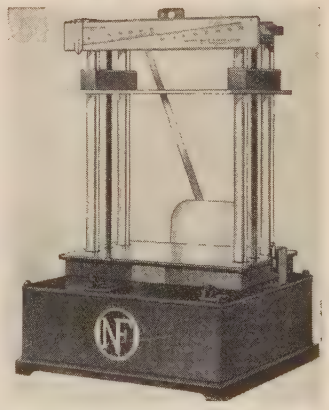

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largest producers of greeting cards, in number of units sold. For example: this year we sold 56 million Valentine cards, and the National Association of Greeting Card Publishers announced last week that the industry this year produced three hundred million (300,000,000) Valentine cards, an all-time high. Our average shipments are almost one million seven hundred and fifty thousand (1,750,000) per day and if placed end-to-end, the annual production would extend 34,500 miles—one and one third times around the earth.

A greeting card is very light in weight, but last year we handled approximately 740 million pounds to produce twelve and one quarter million pounds of finished product. That means we had to handle more than 60 pounds for each pound of cards!

From 1944 to 1946 our total volume doubled, and the 1946 volume has doubled in the 4 years since. Such rapid growth obviously puts a terrific strain on all facilities—offices, production, maintenance, *and* material handling.

Roughly, about half of our total business is "birthday and everyday," and the balance is "holiday," such as Christmas, Valentine, Easter, Mother's Day, etc. The everyday business goes on day after day, but our holiday shipments embrace about 7 months a year. In order to maintain a labor load equally distributed throughout the year, our handling problems were made more acute because we had in our plants and warehouses materials and finished products for a 12-month period, but were moving it out in only 7 months.

Along with this rapid growth and change in manufacturing policy came a production mechanization program and a diversification of products. We also, in this 4-year period, began producing our own boxes, cellophane bags, and envelopes.

In 1946 we had around 114,000 sq. ft. of floor space devoted to warehousing and storage, exclusive of in-process storage, in two locations. We now have 285,000 sq. ft. for this purpose, in five locations.

In 1946 all our material was handled on skids with hand platform trucks. We knew we could not expand as we expected by using our current methods because we did not have enough plant facilities or man power. Our storage areas were ideally suited to high-stacking, but we could not very well double-deck material piled on skids. As part of a program intended to improve all material handling methods, we found it advisable to put all stock on pallets instead of skids.

Now, we had at that time approximately eight thousand skids and forty-four hand platform trucks. We also had one electric platform low-lift truck, and a Tow motor fork high-lift gasoline truck. We had built the skids ourselves, using pine, and had paid between $3.25 and $3.50 each for them. The mortality rate was extremely high, and we found the maintenance and replacement cost was about $1.50 per skid per year.

After we had decided to palletize, we made a thorough study to determine the pallet size. The factors considered were the size of boxes to be handled, the weight of load, and the building restrictions of the storage areas. We standardized on a 120 point solid fiber stock box, $^3/_4$ telescoping, 9 inches wide, $7^1/_2$ inches high and $23^1/_2$ inches long. We determined the pallet should be 36 × 48 inches, single faced, entry at the 36-inch dimension, with $^5/_8$-inch decking. Here we ran into an obstacle. No one made a pallet like this, and furthermore, no one seemed to want to. We finally prevailed upon a pallet company to manufacture them, and they cost us only $2.20 each. Incidentally, I think it is worth noting in passing that this pallet is now a standard item in this company's line.

Our next problem was to acquire an electric fork lift truck to suit our requirements. Because of the pallet size, 2-foot-columns located on 20 foot-centers, and the necessity for maximum floor space utilization, we needed a truck capable of right-angle stacking a 2000-pound load from an aisle $8^1/_2$ feet wide. At that time such a truck was not available. One company had built one experimentally, but was not ready to go into production on it. None of the widely known electric truck manufacturers seemed to think the demand would justify designing such a truck, but persistence once again paid off. Another company had one on the drawing board, and with a little urging on our part speeded up manufacture, and before long we were in business.

An illustration of how important palletization is to our business is shown in this comparison. If we had not paid attention in 1947 to our handling methods, and had continued to move and store material on skids, we would today need 584,000 sq. ft. instead of 285,000 sq. ft. And in 1953, if our growth continues as anticipated, we would need nearly 850,000 sq. ft. of warehousing space. We expect our present facilities will take care of our needs in 1953 through a continuation of an engineered handling program.

The program just outlined has required the purchase of sixteen thousand pallets, with two thousand more now on order; eleven fork electric tiering trucks; four low-lift power trucks; and thirty hand fork trucks. We scrapped eight thousand skids, and sold most of our hand skid trucks. The entire job cost about $140,000 in new equipment, but in rent alone, is saving us $150,000 per year at present.

Labor savings have amounted to nearly $300,000 since the beginning of the program. Total tangible savings have reached the astounding total of more than $700,000 since the program began in 1947! Added to these benefits, we have been able to improve scheduling and reduce operating costs and scrap. It has also had many fringe benefits, because it has been my observation from more than 15 years as an industrial engineer, that good material handling methods and good housekeeping go together, and these help increase production, reduce scrap and costs, and act as a stimulant to continued good management.

It is not necessary to embark upon a program as vast as the palletization program just described. In fact, the proper way to begin is in a small way where the whole organization has an opportunity to feel their way along slowly. Realization of the rather dramatic savings from a number of small installations oftentimes opens the door to a more ambitious program with vastly greater savings.

In closing let me repeat one thing: There is no formula to be used across the board from industry to industry and from plant to plant. Each job must be tailor-made to fit the conditions. In planning a material handling program the best place to start is to not handle the material at all. And don't forget that it is not a mark of indecision to change things—remember that when we're through changing we're through. But above all things, whatever you do, keep your organization informed. Tell them what is to be done, how it is to be done, and why. The best engineered program can, and surely will, fail if information is withheld from your employees—and that includes everyone down to the sweeper. To quote the trite statement in the movie you just saw: "Don't overlook the obvious."

March Meeting

Fifty-five members of the Lake Erie Section were present at the Hickory Grill in Cleveland on Friday, March 16 to hear a discussion of "Waste Reduction."

Robert C. Sterley, Chief Industrial Engineer for the Ohio Boxboard Co., opened the discussion by outlining the waste reduction program currently being carried out by his company. A study had shown that waste over an 8-year period amounted to $11,000,000. It was learned that this figure could be reduced by 48% after studying the causes of such

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waste. A coordinating committee was established with members representing each department to establish reasonable standards of waste on all operations; act as a clearing-house for ideas and suggestions for improvements; develop and provide publicity, such as posters and slogans, and to furnish reports on progress. Mr. Sterley illustrated his discussion with a series of slides showing wasteful practices, waste-reduction posters, and sample charts furnished to management for a measure of waste reduction progress. Mr. Sterley stated that his company felt that considerable progress in waste reduction had taken place. It was stated that $200,000 had been saved in a year with a further waste reduction of $460,000 as an objective.

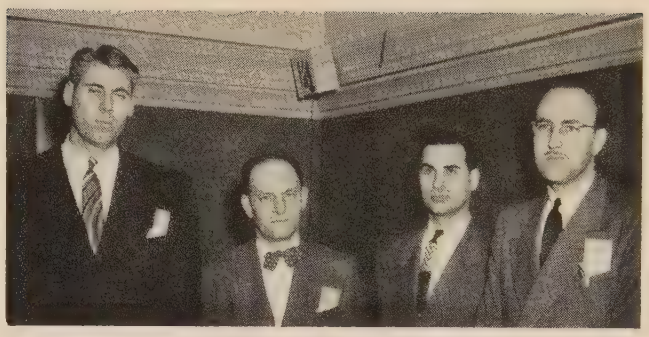
F. D. Long, Technical Director for Container Corp., discussed waste reduction in container plant operations. Mr. Long opened his discussion by stating that there are more potential savings in waste reduction than any other phase of the box shop operation. He defined waste as an item or portion of a product that cannot be sold or used. Mr. Long developed a typical waste picture by assuming a box shop producing 50,000,000 square feet per month with a gross waste of 10% made 5,000,000 sq. ft. of waste. Assigning a value of 2.5% for customers' waste leaves a net waste of 7.5%. If $10 per 1000 square feet is assigned as the value of this material, a net waste of $37,500 per month becomes the goal to work on. A 1% reduction in waste would result in an annual saving of $60,000 which would buy this capital equipment at present costs one printer-slotter, one folder-stitcher, and would still leave enough money to hire three full-time waste supervisors at $5000 per year. Mr. Long stated that waste is as insidious and as fatal as cancer. It must be continuously under observation, must have corrective action, and must be dramatized to the individual. Several means of evaluating waste were discussed and various tools and devices for dramatizing waste were brought up. Mr. Long summarized by stating that waste reduction could be effected through a simple three-step plan namely: an awareness of the problem and a desire to effectively reduce it, an honest evaluation of the causes of waste, and adequate supervision on all shifts.

Many interesting questions were discussed by the speakers during the discussion period and many evidenced a desire for a future meeting on the same subject.

Remarks by Mr. Sterley

I have been asked to outline for you this evening our company's approach to cost reduction in the area of material waste. In my talk I would like to briefly outline and cover the following points: (1) how our program was conceived and started, (2) of what it consists, and (3) what results have been effected.

Our company has been operating a rather comprehensive cost-reduction program for the past 5 years. This program consists of improved manufacturing methods, improved



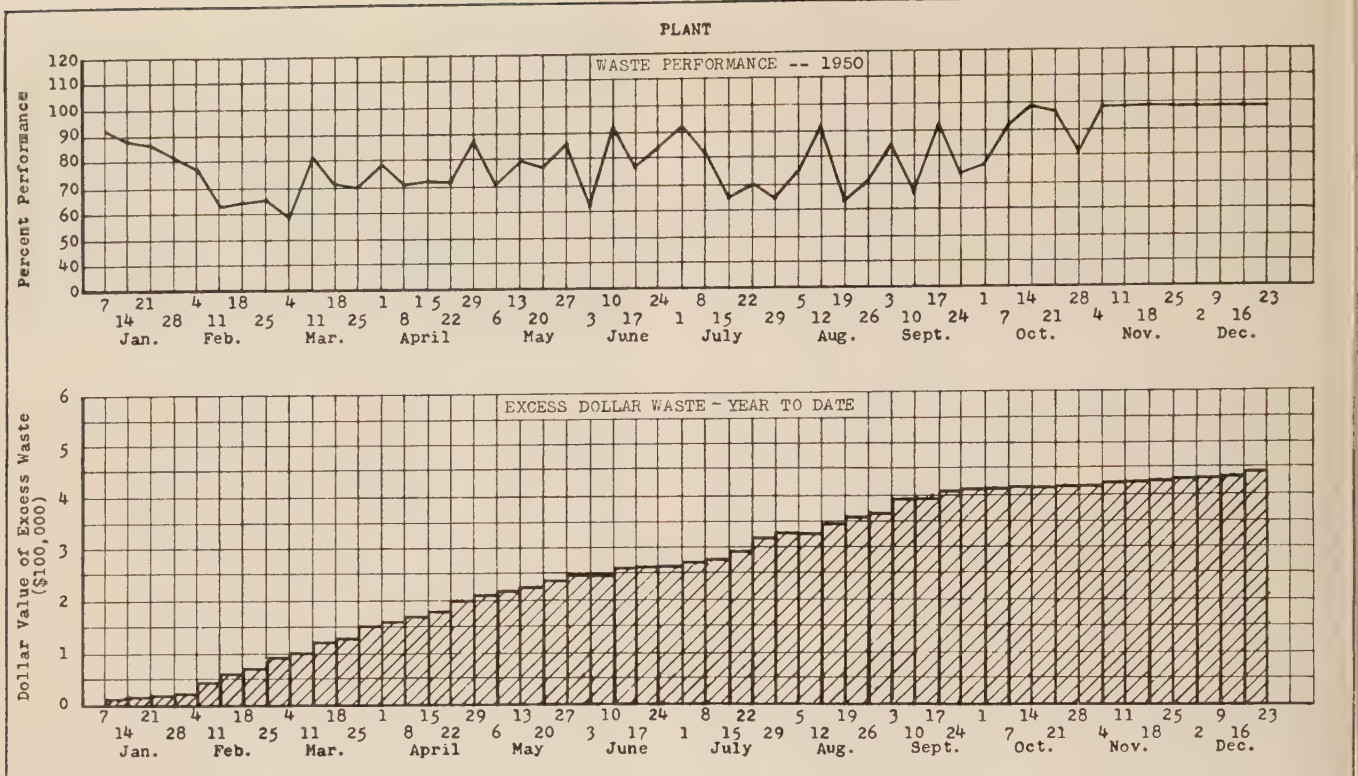
R. C. Sterley, L. K. Burnett, F. D. Long, William Hasselo

scheduling and planning, improved layout of equipment to facilitate a more direct flow of material, the installing of financial wage incentives, supervisory training programs, safety training program, job evaluation, salary evaluation, and many other specialized functions where reductions in cost would result.

We have a rather clear understanding as to the cost of administrating these programs relative to the ultimate dollar savings that can be expected. However, there was an area in which we were lacking sufficient information to determine whether or not we were doing the job required of us. This was in an area of material waste.

In order to determine, therefore, what penalty we were taking in failing to adequately control waste, management assigned to the Industrial Engineering Department the problem of determining the value of waste in our plant. We set to work to determine what contribution each division and department in the plant was making to the over-all cost of material waste. The total figure covering a period of 8 years amounted to a staggering $11,000,000. Recovering from our shock, we were determined to know what would be considered a fair allowable waste percentage that we could expect from our operating divisions. After counciling with our operating heads, we arrived at estimates against which we could measure our past performance and we learned that our material waste could be reduced by 48%. Our problem at this point appeared to be somewhat simpler for we were beginning to approach a better understanding of those elements contributing to the over-all cost of waste. This information was then set forth in the form of a report which was presented to top management. Top management's reaction was about the same as you would expect in your company. The shock wave was followed with some fireworks, and after the smoke had cleared we set to work on a program directed toward waste reduction.

Our problem in developing a waste reduction program was more than merely agreeing that we were going to reduce waste. We felt that certain objectives should be set up that would



establish guide posts for the group that was to direct the over-all program.

A committee chairman was appointed by top management along with members representing each major department in our company. The Committee (hereafter referred to as the Coordinating Committee) was made up of representatives from the following departments:

Sales
Accounting
Industrial Relations
Purchasing
Quality Control
Shipping
Mill Operating
Carton Operating
Container Operating
Maintenance & Engineering
Industrial Engineering (Chairman)

The Coordinating Committee then established the following objectives for the Waste Reduction Program:

1. That standards of waste will be developed on all major and minor pieces of equipment and operations.
2. The Coordinating Committee will function as "coordinator" for interdivisional problems arising from the Waste Reduction Program.
3. The Coordinating Committee will act as a clearinghouse for ideas, suggestions, and proposals for improvements.
4. The Coordinating Committee will develop and provide publicity for acceptance of plant Waste Reduction Program.
5. The Coordinating Committee will review the progress of the Waste Reduction Program and report to top management the results of the program.

We feel that the most important aspect of our Waste Reduction Program is the development and use of waste standards against which operating results can be measured. Long after the publicity of the program has been discontinued, the standards will point up the areas which require attention. The waste standards were developed by consultation with the division and operating heads, and the Coordinating Committee. Once standards were developed, they were to remain in effect for a period of 1 year unless a change in operating conditions warranted revision. Annually, however, the standards will come up for review.

The second aspect of importance in the Waste Reduction Program as operated by The Ohio Boxboard Co. was to provide the necessary plant publicity for the acceptance of the program.

1. We increased our house organ, "In the Box," by 50%. Articles on waste and its costs were featured, also, pictures of waste violations and poor housekeeping.
2. Bulletin boards were strategically located throughout the plant for the purpose of exhibiting results of waste and the causes for waste.
3. Meetings were held with foremen and supervision to determine the *causes for waste* and proposed *remedies*.
4. A slogan contest was developed on a plant-wide and divisional basis with prizes awarded for the best slogan submitted in the plant and smaller prizes to the best in each division.
5. Our biggest publicity stunt was what we called "No Waste Day." On this day each employee and visitor in our plant wore a "No Waste" cap. Three waves of inspection committees inspected the plant starting with first and second line foremen, next division superintendents, and lastly top management and officers of the company. The inspections were made for purposes of good housekeeping, quality workmanship during processing and careful material handling. Departmental ratings were made of each department which were later posted for employee observation. The officers and top management, who rated the departments, also filled out cards asking explanations of waste violations when they occurred. These cards were answered by the foremen, passed to the superintendent, and finally forwarded to the production manager.
6. Publicity for salaried personnel was developed in the form of an office campaign directed toward elimination of wasted time, effort, and supplies. Posters were placed in corridors, catchy slogans were placed on desk cards, telephones, and waste baskets. Inspections were made of offices for good housekeeping. Our office publicity was well received with the spirit of good housekeeping perpetuating itself for weeks after the campaign ended.
7. Lastly, we ran articles on waste and its cost in the community paper, explaining the importance of the program to both the company and to the community.

The reporting of the progress of the program to management was done through weekly performance charts and weekly excess waste charts expressed in dollars.

Over-all plant performance and excess waste cost charts by weeks were distributed to management.

Slides were shown presenting data and pictures of the waste-reduction program.

I will give you some idea as to the responsibilities of the committee members:

Sales

1. Use of art department—posters and displays.
2. Examples of rejects from customers.
3. Make special studies of quality.
4. Expedite proposed manufacturing changes which affect customer.

Accounting Department

1. Provide operating division and committee with performance results.
2. Establish cost variations of the value of excess waste.
3. Evaluate savings of proposed changes.
4. Make recommendations as to clerical changes.

Industrial Relations Department

1. Provide publicity:
   - House organ.
   - Bulletin boards.
   - Management meetings.
2. Reflect employee attitudes toward waste reduction—union management meetings.
3. Recommend measures to be taken to overcome human relations attitudes.

Purchasing Department

1. Provide cost data of raw materials, equipment, and supplies; make recommendations as to economies that could be made.
2. Coordinate suggestions received regarding the more efficient procurement of materials.
3. Recommend the availability of substitutes.

Quality Control Department

1. Bring examples of manufacturing waste to Committee.
2. Make recommendations as to the conservation of raw materials.
3. Supply the Committee with samples of in-process waste

Shipping Department

1. Provide Committee with cost of damaged goods as a result of warehouse and shipping department.
2. Provide Committee with list of materials which had not been shipped within a 30-day period.
3. Make recommendation as to improved scheduling.

Maintenance and Engineering Department

1. Make recommendations for improved mechanical methods resulting in decreased waste.
2. Provide services of trade shops:
   - Tin shop.
   - Carpenter shop.
   - Electricians.
   - Mill-wrights, etc.

The waste-reduction program really got under way during the third quarter of 1950. An idea of the results can be secured from the attached chart. It will be noted that the Waste Performance is approaching 100% while the excess dollar waste, year to date, is beginning to level off.

We feel in our company that considerable progress has been made in reducing waste. In the past year, over $200,000 has been saved. However, we still have a long way to go to accomplish our objective and that is to further reduce waste by $460,000.

Remarks by Mr. Long

The subject of waste in the corrugated box shops is probably as controversial a matter as could be found to discuss. The mere measurement, and segregation of waste, is a very time-consuming and costly procedure. The quantity of waste frequently may be accurately measured by the waste man, but then little effort expended by management to reduce the waste. My personal opinion on the matter is that there is more potential savings in waste reduction than any other phase of the box shop operation. In a discussion, such as this, some generalizations have to be expressed that may not apply to all operations. There are always a few operations or plants that have accomplished waste reduction to a point that it is uneconomical to go much further. These, however, are exceptions. The majority of the operations that we in this room are familiar with have a job to do.

To be sure that we are all able to understand one another, it is necessary to use the same language and definitions. While you may have defined waste in another manner, I am taking the liberty of using definitions which we have adopted, so that you can follow the subject matter which I will present.

What is waste? Generally speaking, waste is an item or portion of a product that cannot be sold or used. In the corrugated box shop, waste is the board produced that is damaged, unused, or otherwise rendered unmerchandisable. The effect of waste is that you have less product to sell and hence less income. Also, and here is the side of the picture we frequently forget, we have expended funds to purchase component materials, employ men and women to fabricate containers, apply adhesives, ink, tape or stitches, handle the board several times, and then throw it away. You still have the manufacturing costs but no return.

Gross waste is defined as the sum total of all items wasted in roll handling, combining, printing, finishing, and handling in the box shops.

Net waste is the gross waste minus customer's trim, salvaged material, and claimed intransit damage.

Customer's waste is die cut cutout waste including trim, flap cut waste, stitch and slotter cutouts, and in certain cases, excessive combiner trim for which the customer is charged. Customer's waste looks easy to measure and control, but it is one of the most tricky of all waste categories to accurately determine.

We could spend the evening on merely defining the waste categories experienced in the box shop, but the foregoing terms are all that we will have time to discuss.

What does corrugated waste mean to you in terms of dollars? I have taken a hypothetical box shop for comparative purposes. Let's assume that this plant produces 50 MM sq. ft. per month. The gross waste is 10%, and that figure occurs more frequently than you might believe. This means that 5 MM sq. ft. of board are wasted each month. Let's assign a value of $10/M sq. ft. to this board. Call this cost at end of combiner or sales value as you will, but you will certainly not be on the high side today. This amounts to $50,000 per month. Let us assume a customer's waste percentage of 2.5% leaving a net waste figure of 7.5%. Our net waste value at $10/M sq. ft. per month is $37,500. We know that all of this 7.5% net waste is not controllable. Just how much of the waste can be reduced depends on the plant, personnel, type of business, effectiveness of the waste reduction program, and a host of other factors. If 1% reduction is effected, the savings per month would be $5000. If a 2.5% reduction to a 5% net waste figure is effected, the savings would be $12,500 per month. Annually a 1% waste reduction would result in a savings to you of $60,000. A 2.5% reduction would save you $150,000. During the last decade of huge governmental expenditures, we have become acclimated to seeing and using figures of 7 to 10 digits quite glibly. Individually, however, we think in terms of our own income of 4 and 5 digits. Imagine if you will $60,000 to $150,000 to play with. Let's put it back in capital equipment for increasing productive capacity and improve quality. What could we buy?

If we had $60,000 we could buy a new printer-slotter for $35,000, one folder stitcher at $10,000, and hire three waste supervisors at $5000 per year apiece. No amortization for 10 years but all paid for. We would have another major producing unit in the line and would assure ourselves that we would continue to keep our waste program effective and have additional funds available next year for more new equipment.

On the other hand, if we had $150,000 available from our waste reduction program, we would be able to buy two printer-slotters for $35,000, two folder tapers at $25,000 each, one folder stitcher at $10,000, three waste supervisors at $5000 each, and have $5000 as a bonus for you as compensation

for having accomplished the job. Or with $150,000, we could buy four printer-slotters at $35,000 each, or six folder tapers at $25,000 each; or 15 folder stitchers at $10,000 each; or hire 30 waste supervisors at $5000 each.

The problem of waste evaluation is a major consideration in any waste reduction program. Each company or plant usually has a slightly different approach. The method of checking can be very simple such as reporting one figure, such as baled waste, or very elaborate, with detailed data of each operation throughout the box shop. Results may be determined, daily, weekly, or monthly.

Generally, most shops have waste data collected in waste categories that cover roll handling, combiner, printing, and finishing. This information usually is reviewed at the end of each month.

Customer's waste is a continual headache in that it involves a lot of detail work to determine it accurately. To be accurate, you would have to collect all of the cutouts from die cuts, trim, flap-cut waste, and stitch and slotter cutouts from each job. No matter how carefully you think you have this covered, the press of business causes the operators to fail to check at times. Since the layout of the job causes the percentage of customer's waste to vary considerably from job to job, these omissions can appreciably affect your data if a long run is involved, or if a large number of orders are missed. One of the common techniques used is to require the printer-slotter operator to check in all cutouts and trim from one blank to the supervisor at the time of prove-up. The supervisor weighs the cutouts and multiplies the weight by the number of containers run to arrive at the total customer waste figure. This naturally is an approximate figure. Pencil calculations based on the estimator's layout of a job are frequently used. Very divergent data from the actual production figures usually are the result.

From time to time, it is helpful to make a detailed study of each operation in the box shop. Habit tends to perpetuate bad operating techniques. Unless these are reviewed and compared to past performance, it is very easy to get out of line.

The units used in reporting waste vary from operation to operation. Weighing and reporting in pounds is the quickest and easiest value to determine in the box shop. Square footage is very difficult to use due to the time required to measure odd-shaped sheets and waste.

The manner in which you break the waste categories down is secondary to the accuracy of the figures collected. Waste reduction cannot be intelligently and economically effected unless you are able to determine the causes of waste. If your system determines the causes and quantity of waste for each cause, it is a good method of evaluation.

Up to now, we have been determining the problem of waste and its causes. The reduction of waste is comparable to the decision facing a surgeon consulting with himself regarding a person needing surgery: "Should I make an incision, perform the operation and have a healthy patient as a result, or let nature run its course, and let the patient suffer and perhaps die from inattention?" Waste is as insidious and as fatal as cancer. It must be continuously under observation, must have corrective action, and must be dramatized to the individual to be effective.

The methods used to reduce the quantity of waste in a box shop are numerous and varied. Usually the plant manager finally gets to the point that the waste figure gets so far out of line that some action must be taken. Discussions with the supervisors bring out a lot of suggestions, and alibis. A period of time elapses and while the waste doesn't get much worse, it doesn't get any better. In desperation, an individual is selected to give his full time to the problem. Since good supervisors are always at a premium, the manager is loath to jeopardize the operation of a smooth-functioning department to an assistant foreman, so a trainee or relatively new employee is selected to do something about waste. He's given a pep talk, assurance of support by management, and the warning not to shut down any production equipment. The trainee, anxious to learn all he can and to impress the boss, is all charged up and goes to work. Despite his lack of background, he can see some obvious ways to effect waste reduction in practically every department. The principal difficulties are that it may affect the quality of the product, thus upsetting the sales department; or by putting his ideas into effect, he places the operators in an unfavorable light because of bad operating habits. He hates to go to the boss so he carefully explores both avenues of approach. Sooner or later he gets into trouble. Discussions are held and a common ground between production, sales, and management is established. Then *if*, and I emphasize *if*, management and supervisors want and are willing to work for it, you commence to get on top of waste. Supervisors' meetings, meetings between operators and supervisors, waste slogans, posters, departmental competitions, and other techniques are all used to make the program effective. Each plant is different, and the approach that will work in one plant may not work in another.

All workmen have pride in their work. Quality programs appeal to this latent quality in a man, whereas, waste reduction is hard to sell to them. Only when he is made to realize the dollar value involved, and what it means to his operation, does it commence to be effective with the operator. Naturally, his first reaction is what does this mean to me at payday? He may counter with a counterproposal for a waste bonus or some sort of incentive. Some operations lend themselves to waste incentives, but others are very difficult to evaluate or reward. The controversy could become very hot and heavy on this point, and I'm sure there are both sides represented here tonight. Suffice to say that to be effective and enduring, any waste incentive must be predicated on accurate factual data, and the resulting savings must be wisely distributed according to effort expended by the individual. Serious trouble is ahead for any system not executed in this manner.

The use of trend charts, to reflect progress in waste reduction with respect to time, are particularly helpful to get across to operators how they are performing their jobs. Competition between crews on a given piece of equipment many times is very effective. These tools are usually good for only a few months time and then other devices are necessary.

My personal opinion on waste reduction is so simple that few will accept the concept. Namely, this is how waste reduction can be effected.

1. An awareness of the problem and desire to effectively reduce it.
2. Honest evaluation of the causes of waste.
3. Adequate supervision on all shifts.

The management and supervisors must want to reduce waste and to improve the efficiency of the plant. The manager can accomplish this, if he so desires.

Any intelligent supervisor or trainee can be freed from his regular duties and be capable of evaluating how much waste is occurring at each operation. Conferences between operators and supervisors can determine the causes. Some may be mechanical and only expenditures of funds by management can correct them. Others may be operational, because of demands by management for increased production. Here management has to weigh the dollar sign between increased sales and increased waste or the other alternative of reduced waste and less production. These factors plus the errors and bad operating techniques on the part of the operators determine the causes and corrective action necessary.

The remaining factor to make the program work is adequate supervision. We carefully allocate so many employees to a supervisor to assure an economical, efficient production operation to get a quality product for the least outlay of cash. We load the day shift up with management and

supervisory assistance. The second shift has far less supervisory coverage and the third shift has a bare minimum of supervision. Waste reduction is only one of a dozen factors that must be considered by the operating supervisor. Whenever he has a few minutes left over, he *may* try to do something about waste but at best it is a few minutes each hour. With the potential savings that can accrue from waste reduction, you can justify *additional* supervisors on *each shift* whose sole responsibility is the determination of waste causes and corrective action. A working balance between the waste and operating supervisors is a must to avoid friction. Again, each plant must work this out in the light of its peculiar set of circumstances.

I hope I have been able to pose the problem to you, and to offer a few suggestions that you may mull over in your minds. This is a tremendous problem with a wonderful pay-out that we all should consider more carefully.

R. L. Lewis, *Recorder*

Ohio

The Ohio Section met on March 8 at the Manchester Hotel in Middletown, Ohio. One hundred and fifteen members and guests were present.

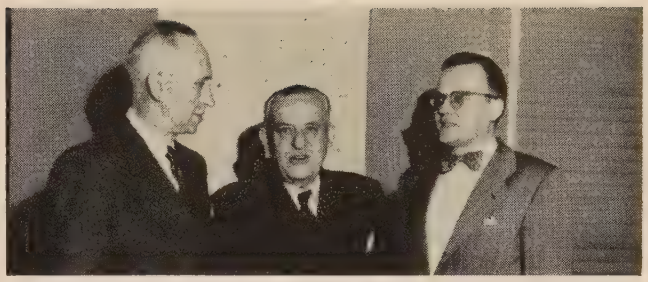
Chairman Donald Goodman introduced TAPPI'S new President, Ken. Geohegan, and expressed to Mr. Geohegan the pleasure that the Ohio Section feels in having one of its members so highly honored. Mr. Geohegan thanked the members of the Ohio Section for the confidence expressed by them in their ovation and talked briefly about plans for a TAPPI program of research to fill the gaps in our present knowledge of pulp and paper manufacture. This TAPPI program will be administered through the various committees that are at present functioning for the National Association. Mr. Geohegan urged all members to be active in their support of the National Association.

Following Mr. Geohegan's remarks, Mr. Goodman introduced E. T. A. Coughlin, Chief of the Paper & Pulp Products Unit of the Chemical and Plastic Section, Research and Development Branch, Military Planning Division of the Office of the Army Quartermaster General. Mr. Coughlin's address was entitled "Military Planning in the Paper Industry."

The speaker discussed some of the wartime uses of paper in relationship to the properties of the paper. It was pointed out that insofar as possible utilization is made of present commercial grades of paper; and that with few exceptions every mill in the Ohio area can produce one or more of these items. The need for a complete index of the types of papers and tonnages that can be produced in each mill was stressed. The mills were urged to describe in a condensed statement on an index card (3 × 5) the particular grades made, the daily tonnage, the maximum and minimum trim, weights, finishes, etc. This information would be of service to the procurement men in the New York Office of the Quartermaster General when special procurements are necessary. Also requested were individual cards (3 × 5) listing on the upper right-hand corner the grade of paper or board with the same basic information on sizes, weights, trims, finishes, colors, and qualities in lower lines.

Mr. Coughlin illustrated his talk with many interesting samples of papers developed for special uses. A large percentage of the papers required by the Quartermaster Corp are used in packaging. The Quartermaster Corps either directly or indirectly is investigating the application of compounds to paper which will impart mildew resistance, insect repellency, and rodent repellency. It is often difficult at the present time to get priviate paper manufacturers to show much interest in these very specialized grades of paper, and a thorough indexing of paper facilities would aid greatly in procurement.

M. G. Lyon, *Recorder*



K. P. Geohegan, E. T. A. Coughlin, D. J. Goodman

Lake States

The March Meeting of the Lake States Section was held at the American Legion Clubhouse in Appleton, Wis., on Tuesday evening, March 13, 1951.

A dinner was held, followed by a panel of three speakers from the Institute of Paper Chemistry. The speakers were: Bernard F. Shema, Research Assistant, who discussed "Micro-biological Control In the Pulp and Paper Industry"; Irwin A. Pearl, Research Associate, who discussed "The Story of Ethyl Vanillate"; and Willis M. Van Horn, Research Associate, who discussed "Pollution Suits."

The speakers were introduced by Chairman Henry Crandall who pointed out the background and experience of each man which made him an authority in his respective field. The ensuing talks were very interesting and significant and received extremely favorable response from the group.

Ethyl Vanillate, by Dr. Pearl

About 10 years ago the Sulphite Pulp Manufacturers' Research League, a group of Wisconsin and one Michigan sulphite pulp mills, initiated at The Institute of Paper Chemistry a research program on the chemical utilization of sulphite waste liquor. One portion of this program was directed toward the use of the chemical vanillin as a raw material. Vanillin was already being produced from sulphite waste liquor and even better processes had then been discovered for its production. The goal of this program was to find other chemicals which might have much broader uses than the limited use of flavoring vanillin, a market which was already saturated.

Processes were discovered for converting vanillin to its derived acid, vanillic acid, which in turn could be esterified to form esters of vanillic acid such as ethyl vanillate, butyl vanillate, etc. During the war these products were found by the Chicago Quartermaster Depot to be useful for the preservation of foods, and toxicity studies indicated that they were relatively nontoxic.

Medical studies were then initiated, and ethyl vanillate was found to be a good agent for the control of fungus diseases of the skin such as athlete's foot, ringworm, etc. Further studies by Amos Christie and co-workers at Vanderbilt University, School of Medicine indicated that ethyl vanillate was useful for the treatment and cure of disseminated histoplasmosis, a fungus disease which in the past had proved uniformly fatal. The results of this study were presented before the meeting of the American Pediatrics Society last May. This paper resulted in a deluge of requests from hospitals all over the country for ethyl vanillate for the treatment of histoplasmosis and a number of related fungus diseases. These studies are under way at the present time. It is too early to have the whole story, but it can be said at this time that ethyl vanillate is doing a job on a number of fungus-caused diseases which in the past have resisted treatment by all agents including all of the recent wonder drugs. Therefore, it appears that in the future the lowly sulphite waste liquor will assume a new role as the raw material for life-saving medicines.

Pollution Suits

Willis M. Van Horn, Biologist on the staff of The Institute of Paper Chemistry, spoke to the group on the subject of "Pollution Suits." He introduced his talk by discussing briefly the history of jurisprudence in the United States. "The Preamble to our Constitution says that all men have inalienable rights"; he stated, "this implies that if his rights are violated he has recourse to law." "At the same time our Constitution says that one of the functions of government is to promote the common welfare. It often happens that the common welfare may be inimical to the rights of the individual. When this happens it is up to our courts to decide at what point, in the interest of all, that common right transcends individual right."

The speaker then compared the scientific method and the method used in many of our courts for establishing fact and truth. "Whereas," he said, "in the scientific method we try to establish the fact by observations and experiments and by a critical analysis of the resulting data, the court method is based on direct and cross-examination of witnesses. This method may have certain inherent difficulties because in most cases a witness must rely on his memory when stating his facts.

"The fact of the matter is that court procedures employed for establishing truth and those employed by scientists are quite divergent both in philosophy and concept. When they converge, as in the case of water pollution damage suits, some confusion may result. As scientists, we are often at a loss to understand why facts of long standing are not acceptable in court. We must remember, however, that the gentlemen of the legal profession often have as much difficulty in understanding our point of view as we have in understanding theirs. Their system has been set up in an honest effort to provide justice for all; it has done a fine job because our courts are among the best in the world."

The speaker illustrated his points by recalling experiences while serving as an expert witness in water pollution damage suits.

Microbiological Control

B. F. Shema, Microbiologist on the staff of The Institute of Paper Chemistry, spoke to the group on microbiological control in the pulp and paper industry.

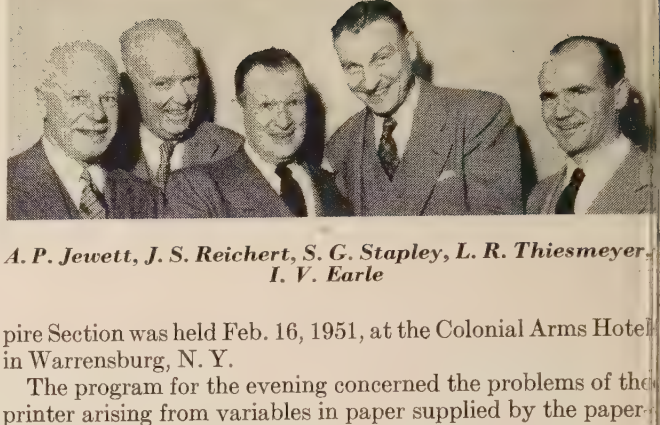
He discussed some of the major microbiological problems facing pulp and paper manufacture today. The problems discussed were (1) preservation of papermakers' woolen felts; (2) preservation of wet lap stock; (3) production of mildew-resistant papers; (4) sanitary aspects of paper with particular emphasis on food containers; and (5) slime control. He pointed out that adequate microorganism control will result in increased felt life, increased production, and improvement in the quality of the finished products. He stated also that there is a definite need for new microbicides, especially for the preservation of woolen felts. The application of various fungicides and bactericides were discussed from the standpoint of their effcetiveness in preventing the growth of various microorganisms on paper products and in mill systems.

The sanitary quality of paper was also discussed. It was pointed out that from the public health point of view paper is an ideal medium for packaging food. The speaker presented data on the lethal effect of the temperature of the drier rolls on the bacteria present in the wet web. The data presented showed that the only bacteria surviving in the paper are the spore-forming nonpathogenic types.

The speaker concluded his talk with a discussion of variables that should be considered in planning a treatment regimen for the control of slime in pulp and paper mills.

Empire State (Eastern District)

The February meeting of the Eastern District of the Empire Section was held Feb. 16, 1951, at the Colonial Arms Hotel in Warrensburg, N. Y.



A. P. Jewett, J. S. Reichert, S. G. Stapley, L. R. Thiesmeyer, I. V. Earle

The program for the evening concerned the problems of the printer arising from variables in paper supplied by the papermaker. The speaker was Louis F. Engelhart of the Eastern Research and Development Laboratory of the International Printing Ink, Division of Interchemical Corporation at Elizabeth, N. J. Mr. Engelhart delivered a paper entitled "Paper and Board Characteristics that Affect Inks and Printability" which will appear in a later issue of *Tappi*.

Following the speaking, an open discussion period was held, after which a movie entitled "Rainbows To Order" was shown.

ROBERT B. BLAKESLEE, *Publicity Chairman*

Empire State (Western District)

March Meeting

Technical cooperation that crosses international boundaries and is supported by competitive companies was described on March 13, 1951, by Lincoln R. Thiesmeyer of the Pulp and Paper Research Institute of Canada, Montreal, P. Q., speaking to a joint meeting of the Eastern District Empire State Section and the Niagara Branch, C.P.P.A. Technical Section at the Queensbury Hotel in St. Catherines, Ont.

Dr. Thiesmeyer stated that twelve companies are cooperating in one $170,000 project to find out how to prevent alkaline corrosion of pulp and paper machines. Free access has been granted the Institute to information collected by the United States group of pulp researchers, and another Canadian group at Appleton, studying the same problem is providing information. A "task force" of three specialists will live at each of the paper mills with a corrosion problem for one or two weeks. The mass of detailed information will be coded and put on punch cards. A U. S. nickel company has offered the use of its specialized business machines to sort the coded information and discover trends in the mass of information.

Another project now under way gives promise of a possible saving of 72% of the sulphur used in papermaking. If the project proves successful on the commercial level, it would have far-reaching effects in eliminating the present shortage of sulphur. "There is nothing certain yet," he said, "but results so far have been so challenging that we must follow it to the end." A pilot plant is available for a large-scale test, and results this year should show whether the 72% saving can actually be made. Sulphur is used extensively in papermaking, and much of it is lost at the end of the process and runs off as waste material. The purpose of the present experiment is to devise a means of extracting usable sulphur from the liquid waste.

Sulphur may be saved in other ways, for instance in the cooking of the pulp, said Dr. Thiesmeyer. A report of saving methods will be issued soon.

A. P. Jewett of Provincial Paper Co., introduced Dr. Thiesmeyer, and the speaker was thanked by L. C. Anderson of the Ontario Paper Co. Mr. Anderson declared that the benefits of the research being carried on by Dr. Thiesmeyer's agency would spread all over North America.

Front, l. to r.: S. G. Stapley, Hon. William H. Lee, G. Storin
Back, l. to r.: H. J. Perry, R. T. Yates, I. V. Earle

Steven G. Stapley, Chairman of the Niagara Branch of the Canadian Pulp and Paper Association, welcomed the United States visitors to the meeting. Leader of the U. S. group was Irving Earle, Chairman of the Western New York District of the Empire State Branch.

Speaking of the international situation, Dr. Thiesmeyer said that obstruction by some countries in the United Nations had forced greater cooperation among the other nations. He called for a United Nations police force to keep aggressor nations in check. If the situation in Korea has taught us nothing more than that we can have no world order without an international police force, then the sacrifices of lives in Korea have advanced man toward his ideal of the world society. In search of this ideal, cooperation is more valuable than a struggle for survival. In a cooperative effort, each contributes what he can toward a common goal.

April Meeting

Irving V. Earle, Upson Co., Lockport, N. Y., was re-elected chairman of the Western New York Group, Empire State Section of TAPPI at the closing meeting of the 1950–1951 season held on April 5. Other officers elected were G. K. Storin, Niagara Alkali Co., Niagara Falls, Vice-Chairman; F. P. Heil, Lockport Felt Co., Newfane, N. Y., Secretary; J. J. Forsythe, International Paper Co., Niagara Falls, N. Y., Treasurer.

Committee chairmen for the coming year will be M. S. Scaletta, International Paper Co., Publicity Chairman; R. Winship, Moore Business Forms, Publicity Vice-Chairman; D. Hart, Moore Business Forms, Program Chairman; E. F. Andrews, International Paper Co., Program Vice-Chairman; George Norton, George Irish Paper Co., Membership Chairman; R. Vaeth, Robert Gair Co., Membership Vice-Chairman; F. B. Pickett, Kimberly Clark, Attendance Chairman; and R. J. Driscoll, International Paper Co., Arrangements Chairman.

Gordan Storin introduced the speaker of the evening, Henry J. Perry, Editor of the *Paper Trade Journal*, who spoke on the topic "What Are the Problems of the Paper Industry?"

"The major problems today," said Mr. Perry, "are the shortages of materials, present Government policies, the lack of long-term economic stability, the lack of the right kind of leaders in Washington, and the excessive buying of certain Government agencies." Among the remedies suggested by Mr. Perry as contributions which could be made by periodicals and other publishers were:

1. Keep Washington and Congress informed of the problems faced by the paper industry.
2. Keep the public informed.
3. Stress the conservation of critical materials.
4. Use of editorial power to get the Government to take proper remedies.
5. Campaign for risk capital.

Empire State (Metropolitan District)

The Metropolitan District, Empire State Section met on Tuesday, April 3, at 6:15 p.m. at Fraunces Tavern, Pearl and Broad Streets, New York City. The topic was the all-important one of waste paper. In addition to the economics of the situation, the supply and demand picture, there are new problems which face all suppliers and consumers such as the occurrence in paper stock of wet-strength papers, papers coated with new resins, and the like.

The speakers were S. I. Hershman of I. Hershman and Co., Inc., New Haven, Conn., J. A. Cauwels, Purchasing Agent, Federal Paper Board Co., Inc., Bogota, N. J., and Anthony Gaccione, President, Toga Paper Stock Co., Inc., 120 Wall St., New York City. Mr. Gaccione is also president of the 50-year-old New York Association of Dealers in Paper Mill Supplies.

The meeting was "off the record" and an interesting discussion followed the talks.

J. F. Butterworth, *Secretary-Treasurer*

Empire State (Northern District)

The Northern District of the Empire State Section met at the Woodruff Hotel in Watertown on Thursday, March 9 for dinner and its regular monthly meeting.

Harold Spector, the Chairman of the group presided. Ralph Prince, the Secretary-Treasurer of the Empire State Section gave a brief report on the relative standing of this division in the Section, and also a preview of the plans being made for the annual meeting in June of the Empire State Section. The future of the paper industry in New York State will be discussed by speakers chosen from diversified fields.

The report of the Nominating Committee under the chairmanship of Horace Spencer presented the following slate of officers for the Northern Division to serve next season: Chairman, Wayne Morrow; Vice-Chairman, Richard Premo; Secretary, Lois Hans; Treasurer, John H. Treadwell; and Executive Committee, Harold Spector, Thomas Loessi, Donald F. Ferguson, Roger Schwartz, and Maurice Myers. Since no other nominations were made from the floor, the slate presented by the committee was adopted.

Jack T. Wilson, chief physicist of Allis-Chalmers Manufacturing Co., Milwaukee, Wis., gave an extemporaneous discussion on "How the Engineer Can Help the Doctor Save Your Life."

Dr. Wilson's remarks follow:

Our recent study of science is only a scratch on the surface of the long history of the earth. If you had a book of 2000 pages and devoted a page to each 10,000 years, you would only start the history of mankind on the very last page and in the middle of this last page you would start with the earliest recorded history of mankind. The present achievements would take the last word of the last sentence in such a history. This short section of world history is what we are concerned with at the present time.

One of the outstanding things about human achievement is the use of fire—that man has had control of fire in order to make his life more abundant. Man took it as something commonplace in the universe, and looking at the sun, thought that here is the ultimate manifestation of fire. In reality, the earth is a very unique place, for the most powerful telescopes have not been able to prove that there is a single other place in the universe that fire as we know it can exist. Therefore, fire burning the products of vegetation is highly significant. What had seemed commonplace—the uniting of oxygen with other elements and giving off of energy is now known to be unique—that this should be found coming from combinations of oxygen, carbon, and hydrogen—it has been only in the past 10 or 15 years that we have found evidence that the energy developed by the sun or the stars was not developed by oxidation—that energy produced was due to changes in the nuclei of atoms. We have come to see one type of atom transform itself into another type to give off energy. After the last 10,000 years' observation and study of the materials around us, we have the following views on the composition of matter. First, the basic unit of structure is the electron signified by the symbol O− which carries in addition an

electrical charge of negative nature. Second, another unit of matter signified by O+, or positron, which also carries an electrical charge, but this charge is opposite to that of electron.

Very recently we have achieved another step in our knowledge—by shooting one of the electrons into a positron a beam of light is formed. That is not true if we get the electrons and positrons in groups. A neutron = O, and is formed by approximately 900 O− and 900 O+, or 1800 total mass. It took our scientists many years of research to arrive at the theory that all matter is an aggregate of mechanical particles and can be described as any other mechanical system. We are now able to stress a particle, or a system of particles. Such a highly complex system can under stress fire off at high speed an electron sometimes called a beta particle, thus removing an electron or a positron from the system. The result is the production of a proton. The whole universe is constructed by complex arrangements of these particles.

Back, not so many years ago, we were taught that the basic materials of the universe were elements which were indivisible—and could be classified in our simple atomic table. We now know that this concept was an error—take a single simple example—the first element on the table—hydrogen. Hydrogen is a family of elements and is not a single indivisible element. This family of three elements, each very similar in chemical nature and reactions, will differ only in mass. The stability of an atom is entirely determined by the number of neutrons in its nucleus. Fire a neutron at this body and you have heavy hydrogen. Fire another neutron into this structure, you have titrium. In the nature of this atomic structure, a stress is produced that must be relieved, or a radioactive isotope is formed. The nucleus is no longer stable. This behavior is not confined to hydrogen alone but is possible on any of the 98 elements in the atomic table. Each time we overload the atom with neutrons there is a transformation of the atomic architecture and a great deal of energy may be expended.

A part of this science has been done by research in government laboratories, a part in industrial and educational laboratories. The greatest program is that concerning the well-being and health of humanity. However, we have found that the knowledge of identical riddles concerning matter has contributed to advancement in many widely different fields. That is what happened to aluminum, to sugar, to radio, etc., to mention a few, where techniques developed in other fields had been added to our knowledge. Therefore to restrict research, or to control it by a central body—be it government or by a research council—would limit progress in all fields. We must preserve competitive and unrestricted investigation.

In 1913, at Johns Hopkins University, the great surgeon L. B. Rowntree noted that 6 to 8 people out of 100 died because the toxic poisons could not be removed from their bodies by the kidneys when temporary kidney failure occurred. He stated that if he could be provided with two essential things, he could devise a machine that could remove the toxins and relieve the strain from the kidneys long enough for nature to repair them. The two essentials were (1) some chemical which would keep the blood from clotting, but would not destroy the protein corpuscles; and (2) a membranelike tissue or paper that would pass the toxic particles from the blood but would keep back the larger protein molecules.

In 1941 a few chemists from American Cyanamid Co. went fishing and were attacked by leeches in a fishing stream. As they waded out of the stream and picked off the obnoxious pests, they noticed that the places where they had been bitten continued to bleed for many minutes or even hours after the normal clotting time of the blood. They recalled that alchemists had used leeches as bleeders for centuries. These chemists collected hundreds of these leeches and ground them up in the laboratory, extracting various substances. One of these chemicals was a crystalline fine white powder which kept the blood from coagulating. Because this chemical also disintegrated the white cells in the blood, it could not be used. They were able to use radioactive carbon in tracing the various component parts of the chemical and were finally able to isolate and remove the harmful molecular element forms which were destructive to the protein molecules. This compound, now known as heparin, was finally developed from the ordinary iris leaf and is now used in medicine to keep the blood in fluid state.

In 1945, the Armour Packing Co. in Chicago decided to develop a bigger and better frankfurter—one that would be resistant to all the abuses when it goes on a picnic. One can roast it over a fire and still keep the succulent juices inside—or the American housewife can boil it in salt water and serve it with sauer kraut without losing the meat juices. One that would not taste like leather when eaten. This called for a highly specialized sort of construction, for it must be composed of a digestible material that would not keep one awake at night. It was found that cellulose acetate could be used as a base—it was economically feasible and large quantities could be obtained for it was a product already being manufactured for photographic films.

In the small town of Kampen, Netherlands, Dr. Kolff watched his wife prepare some of these new frankfurters, and he recognized the possibility of this casing fulfilling the requirements of the second essential listed by Dr. Rowntree, while the first was filled by the newly discovered drug, heparin. Dr. Kolff ordered a thousand feet of the casing, and with the help of a neighbor built a crude apparatus with a framework of three wooden wheels driven with a washing machine motor. The casing was wound around the cylinder like framework and blood was forced through and circulated. A patient who was already dying from kidney trouble was attached to this apparatus, and as his blood was being circulated through this machine and then back into his veins, the toxic portions in the blood were being removed by the salt and sugar bath surrounding the casing tube. After a short while the patient opened his eyes, then slept for a while, then sat up and asked for food. He lived and recovered from his illness. Many people were treated in this way, and although some did die, none died from the direct results of this treatment, but from other causes. Dr. Kolff was invited to come to the United States and tell us about it. Tests were conducted at Mt. Sinai Hospital in New York—these tests were made in 1948 using the same crude device. Attention given to it at the time was an item appearing in a New York newspaper, but one of the Allis Chalmers executives saw it. He suggested that it be turned over to the research department to develop an instrument which would help in the treatment of uremia. This instrument was given to the Columbia Hospital in Milwaukee as a gift in June, 1949. It wasn't until November that we had the ideal chance to test the machine—for always before, the patients took one look at it and promptly got well enough not to need it. In November a furniture manufacturer from Grand Rapids went hunting against his doctor's orders. He had an allergy for animal hair, and he also had a cold. He skinned the deer, which he shot, and the allergy brought on pneumonia. He was being flown to Minneapolis but a snow storm forced down the plane at Milwaukee. The doctor said there was no use trying to take him any farther—that his only hope was for the local urologists to take over. They came to the conclusion that the artificial kidney was the only hope left. The treatment was used and the artificial kidney did its work—the man recovered consciousness and wanted something to eat. This man was a salesman—insisted on having in the press and pictures taken of the treatment.

We now have eleven machines in use scattered over the United States. This is only one of many ways that industry can help save lives. Private research in medicine has had some success using an artificial heart with cows and sheep. From the okra plant we have been able to make a compound that added to water may form a substitute for human blood plasma.

Description of the Clinical Operation of the Kidney. Going back to the operation of the artificial kidney, the casing is tested carefully to avoid leaks in the membrane, and a pint of donor's blood of the same compatible type is run through the machine into the patient. The casing is wound upon the cylindrical form and is washed in a bath containing 2000 grams of glucose, 600 grams of NaCl, 225 grams $NaHCO_2$, and 34 grams of KCl. This tubing is wound on a stainless steel reel, and it takes only 40 minutes time to prepare the machine for use.

This treatment is of no value in curing a patient suffering from cancer of the kidneys, nor can it permanently replace the natural kidney suffering from chronic diseases of the kidneys. This is one example of how industry through knowledge has made a contribution to the medical profession in helping save your life, and we hope that it is a step forward in further cooperative service.

The meeting was thrown open for questions to be asked from floor.

Question: Do you find it necessary to use a new membrane for each time the machine is used?

Answer: Yes, and it is supplied in a special sterilized package ready for use at a cost of approximately $5.00.

Question: How long does it take for a treatment?

Answer: An average of five hours—will remove sufficient toxic elements from the blood to allow the patient to go 8 or 9 days after its use even if his kidneys do not work in the meantime. One of our outstanding cases was a young mother giving birth to her third child. The kidney was damaged and she had gone 11 days without passing urine. As she was about to die, she was placed on the machine and improved clinically so much that the physicians were able to operate and repair the kidneys damaged during childbirth. She was given a second treatment when the kidneys still didn't work, after which natural kidney action was restored and she went home well.

Question: Is there any special reason for using 136 feet of casing?

Answer: This length is based on the calculations made by Dr. Kolff on the square centimeter surface of the membranes in the average kidney.

Question: How much solution is used?

Answer: The normal kidney utilizes about 26 quarts of water in 24 hours, but only a portion passes as urine. In the use of the artificial kidney, the concentration of the blood and dehydration is watched and more sugar is added to the bath as required to keep the proper balance. In kidney research, a dog's kidneys were removed and the animal was kept alive for 30 days with the artificial kidney, but some ingredient in the blood was removed and affected the blood pressure which has not yet been traced down.

Question: Haven't kidneys been transplanted?

Answer: Successful transplanting of normal kidneys for a diseased kidney is a matter of record. Some of the patients are still alive although the operations occured many months ago. The artificial kidney is a temporary treatment, taking toxins out of the blood to relieve the kidneys until normal action can be restored. It is useless as a total substitute upon which to exist.

Question: Can the artificial kidney be used for urea poisoning, or Bright's Disease, and would the kidneys become more or less normal after several treatments?

Answer: Prolonged kidney failure is not successfully treated.

Question: Would it be useful in the treatment of leukemia?

Answer: There would be no effect on leukemia, because this disease is due to certain abnormal reproduction rates. The blood cells are never filtered out by the use of the artificial kidney.

Lois V. Hans, *Secretary*

EMPLOYMENT SERVICE

Positions Wanted

E106-51. Superintendent. Broad experience as practical paper maker with considerable technical training. Proved ability in Fourdrinier and Yankee machine mills manufacturing highly specialized grades. Age 43.

E117-51. Pulp and Paper Technologist, 27, Veteran. B.S. and M.S. Wood Technology, N. Y. State Coll. Forestry. 1 1/2 years experience as research chemist with industrial research laboratory. Publications. Desires responsible position with progressive organization.

E118-51. Chemical Engineer. 27. Family. M.S. Yale University 1951. Undergraduate degree in chemistry (honors). Desires position in technical or educational field. Teaching experience. Prefer location in Northeast.

E119-51. Man with 30 years' experience of broad technical and practical background, desires new association with management of either old established organization or new paper project. Experienced in all types of pulp and paper.

E120-51. Chemical Engineer, 21, married, 1951 graduate with B.Ch.E. from Brooklyn Polytechnic Institute. Desires position in production or process development. Location immaterial. Available in June.

E121-51. Pulp Mill Superintendent. Graduate chemical engineer with 15 years' experience in operation and technical control of bleached kraft pulp mills including organization and startup of new mills.

E122-51. Chemical Patent Attorney. Ph.D., Columbia University, 1937; registered before the U. S. Patent Office; over 5 years' patent experience plus 5 years' industrial experience. Age 43, married and draft-exempt. Fields of special knowledge: pulp and paper, petroleum, plastics, and synthetic patents.

E123-51. Bachelor of Science with 10 years' diversified experience in the paper industry desires position as Assistant Superintendent or Assistant Mill Manager. Experience includes work in pulp and paper laboratories, technical mill control, scheduling and production for a paper mill and small bleach plant, paper converting and paper coating both on and off the machine, and as a department head the supervision of 25 production employees.

Positions Open

P98-51. Sales Engineer. Immediate opening for technically qualified man, familiar with alkaline pulping and all pulp and paper mill processes, to head promotion work at home office of leading manufacturer of industrial instruments. Occasional traveling. Location: New England. Graduate chemical or mechanical engineer preferred. Position permanent. Salary. Good company to work for; congenial associates. Send full particulars.

P113-51. Process Engineer—Mica Paper Products. Manufacturer with headquarters in central Ohio needs a chemical engineer with experience in operation of paper mill machinery to coordinate and direct the layout and design of mica paper equipment. Excellent opportunity for advancement in a growing industry.

P114-51. Research Chemist. Large research and development laboratory has excellent opening for experienced paper chemist. Ph.D. preferred. Location: near New York City. Submit outline of qualifications.

P118-51. Instrument Mechanic or Instrument Engineer wanted. Kraft pulp mill, bleached and unbleached, located on British Columbia, West Coast, has opening for qualified, industrious instrument man with excellent opportunities for advancement. Please state experience, age, status, and salary range expected, first letter.

P119-51. Paper Chemicals Sales Engineer. College training in chemistry, chemical engineering, or pulp and paper. Age 30 to 40. 3 to 10 years' paper mill experience in beater room or stock preparation with good knowledge of furnishers. Fourdrinier or cylinder machine experience desirable. Man will assist territorial salesmen in selling paper chemicals throughout the country, making sales calls, and running mill trials. Good writing ability desirable.

P120-51. Coating Research. Chemical engineer, physical or colloid chemist having 1/2 to 5 years' experience in aqueous coatings for paper. Position on staff in development laboratory of nationally known company. Location: N. W. suburb of Chicago.

P121-51. Pulp Mill Superintendent. With considerable experience in alkaline pulping, recovery, and bleaching, to operate a modified-soda mill. Give complete record of education and experience in first letter.

P122-51. Pulp Mill Tour Foreman. Experienced in manufacture of soda or sulphate pulp. Must be able to get along with and command the respect of workmen. Furnish complete record of experience.

P123-51. Superintendent of Finishing Mill. Outstanding paper convertor in midwest has exceptional opening for man familiar with brush coaters, air knife coaters, and other related equipment. Must have a record of successful operation in this field. In reply give complete information as to age, education, salary, family, and reason for seeking change. Also please send photo.

RECENT BOOKS

Structure of Molecules. By K. K. Syrkin and M. E. Dyatkina (Translated by M. A. Patridge and D. O. Jordan). New York. Interscience Publishers, Inc. 1950. Cloth. 6 × 10, 509 pages. $8.75.

The translation is based on the Russian edition published in 1946. During the translation the authors found it necessary to revise some of the text due to advances made in the subject.

Among the subjects covered are theories of atomic structure, periodic classification of the elements, the covalent bond, saturation and direction of valency bonds, resonance of co-valent and ionic states, spectra of diatomic molecules, dipoles, bond energies, chemical bond in crystals, the polyelectron problem of resonance energy.

A firm foundation in organic and physical chemistry is required for an understanding of the book.

Forest Products. By Nelson C. Brown, Professor of Forest Utilization, New York State College of Forestry. New York. John Wiley & Sons, Inc. Cloth. 5 1/2 × 8 1/2, 399 pages, 155 Illustrations. $5.00.

The many graduates of the N.Y.S.C.F. in the pulp and paper industry are familiar with the teachings of Dr. Brown. This book deals with the harvesting, processing, and marketing of material other than lumber. It begins with a review of the history, economics, statistics, and methods of cutting in the woods.

Of interest to this industry are such subjects as wood pulp and its products, naval stores, extractives, tannins, and bark. An excellent glossary is appended.

Note: Books reviewed in this section may be obtained from the Book Dept., *Tappi*, 122 East 42nd Street, New York 17, N. Y.

Vinyon HH Staple

HOWARD E. SHEARER

Vinyon HH staple is a synthetic fiber spun from a solution of copolymerized vinyl chloride and vinyl acetate. As staple, it has found varied fields of usefulness because of its many unique properties. While the UST Vinyon HH staple has been on the market for some years, the MST type of Vinyon HH staple is just currently being introduced by American Viscose Corp.

The raw material for Vinyon HH staple is a thermoplastic copolymer of vinyl chloride and vinyl acetate. Polyvinyl chloride alone is a hard, tough, water white resin which for extrusion purposes must be plasticized because it has a low decomposition temperature and decomposes as it softens. Polyvinyl acetate, on the other hand, is a clear resin of good acetone solubility which softens at only a few degrees above room temperature. While mixtures of these polymers have not displayed particular promising properties, resins produced by the simultaneous polymerization of mixtures of the monomers exhibit several remarkable characteristics.

PROPERTIES

Outstanding among the characteristics of the resin from which Vinyon HH is spun are: exceptional water resistance, high resistance to acids and alkalies, and insolubility in gasoline, mineral oils, alcohols, and glycols. As the copolymer is internally plasticized by the vinyl acetate, no added plasticizer is needed to spin from the dope a soft flexible fiber, of specific gravity 1.34 to 1.36, possessing desirable heat sealing and bonding properties.

Staple Size

The denier and range of staple length in which Vinyon HH may be supplied are given in Table I. Opened staple is recommended for other than papermaking uses. The textile processor will find it exceedingly difficult to do an adequate opening job unless the staple has received the preliminary opening at time of manufacture. For paper use it may be more advantageous to use the unopened staple as it is lower in price and disperses more readily in the beater. Due to the ease with which the fiber elongates under stress and contracts under heat, considerable variation in staple length is to be expected.

Chemical Resistance

Like the resin from which it is spun, the staple has excellent resistance to attack at room temperatures by concentrated acids such as sulphuric, nitric, hydrochloric, hydrofluoric, or even aqua regia. It is resistant to 30% caustic soda or potash solutions, and to 28% ammonium hydroxide. Salt solutions and cuprammonium solutions have no effect on it. Alcohols, glycols, or aliphatic hydrocarbons such as gasoline and mineral oils do not attack it. On the other hand, it is dissolved by ketones and softened or partly dissolved by esters, ethers, aromatic hydrocarbons, and some amines and halogenated hydrocarbons. At elevated temperatures, mineral acids may char and embrittle the fiber. An example of the resistance of the fiber to sulphuric acid at elevated temperatures is given in Table II.

Above the acid reaction point, as indicated in Table II, the staple turns gray to black, but retains its fibrous formation rather than becoming a gummy mass as do many of the other resin fibers.

Table I

2 denier	3/4 to 5 inches
3 denier	1/2 to 5 inches
5.5 denier	1/4 to 5 inches

Howard E. Shearer, Textile Research Dept., American Viscose Corp.

Table II. Sulphuric Acid Resistance of Vinyon HH

Temperature, °F.	*Maximum acid concentration without noticeable chemical action, %*
77	95
135	80
158	75
176	65

One of the most important properties of the staple is that it is practically as strong when wet as when dry. The fiber is actually water repellant, absorbing less than 0.1% moisture. However, it may be surface wetted by various wetting agents. Another important property is that it will not support combustion. Still another is that it will not mildew, as bacteria, mold, and fungi will not grow upon it. It is a poor conductor of electricity, having a dielectric strength of 650 volts per mil.

Effect of Heat

Perhaps the most important characteristic of Vinyon HH staple is the ability to soften, shrink, and bond to other fibers under pressure in the presence of heat and certain solvents. The ability to shrink, either alone or in combination with other fibers or yarns, is made use of in the manufacture of such articles as rubber coated elastic fabrics and embossed carpets. The ability to bond to other fibers is successfully utilized in the manufacture of pressed felts, bonded fabrics, and specialty papers. The bond tends to improve the strength and texture of the material, and stabilizes it against dimensional change when either wet or dry. Temperatures at which various changes in the character of the staple may be observed are given in Table III.

The temperatures given in Table III represent ranges within which the conditions mentioned are first evidenced in a loosely assembled fibrous mat. There is no distinct temperature at which these changes take place and some variation will be noted under different conditions of processing and use. The time and type of heating, as well as the temperature, will effect the bonding or sealing as well as the shrinkage. In all cases, some pressure is required to effectively bond the staple either to itself (unless melted) or to other fibers. Effective shrinkage and tacky temperatures are usually well above the initial range indicated and are influenced by the amount and form in which the staple is present.

BONDING PROBLEMS

While the range between tacky and melting temperatures appears quite large, the effective range for satisfactory bonding is actually very narrow and approaches the melting temperature of the staple. For continuous production bonding, where the heat and pressure are applied in a matter of seconds, the temperature of the heating element or unit must generally be maintained at about the melting range of the Vinyon. In this critical region, the temperature must be closely controlled and the pressure kept at a minimum consistent with an acceptable finish. There is always the probability that a few loosely held surface fibers may slough off the web or material being bonded, adhere to the hot metal, and melt thereon. If this occurs, the chances are that other fibers will build upon the melted ones until there comes a time that the entire surface of the material passing over this point may be ruptured. Only by careful control of the time, temperature, and pressure and prevention of fibers melting on the heated pressure drums or platens can such trouble be averted. Happily these can be adequately controlled either automatically or by careful personal supervision.

Table III. Effect of Heat on Vinyon HH Staple

Softening temperature	125–140°F.
Shrinkage temperature	140–150°F.
Tacky temperature	185–215°F.
Melting temperature	275–300°F.

Table IV. Effect of Vinyon HH Content on Strength of Bonded Rayon, Cotton, and Wool Mats

Blend	Direction	Thickness, mils	Density, g./cc.	Weight oz./sq. yd.	Strength, lb./in.
5% Vinyon—95% rayon	M.D.[a]	14	0.40	4.2	7.2
5% Vinyon—95% cotton	M.D.	16	0.38	4.6	2.4
5% Vinyon—95% rayon	C.D.[b]	16	0.40	4.8	7.1
5% Vinyon—95% cotton	C.D.	16	0.35	4.2	1.6
10% Vinyon—90% rayon	M.D.	14	0.44	4.6	18.9
10% Vinyon—90% cotton	M.D.	15	0.38	4.3	6.3
10% Vinyon—90% wool	M.D.	13	0.53	5.2	4.0
10% Vinyon—90% rayon	C.D.	13	0.44	4.3	16.0
10% Vinyon—90% cotton	C.D.	15	0.38	4.3	3.7
10% Vinyon—90% wool	C.D.	13	0.50	4.9	2.7
15% Vinyon—85% rayon	M.D.	13	0.38	3.7	40.8
15% Vinyon—85% cotton	M.D.	15	0.38	4.3	10.3
15% Vinyon—85% wool	M.D.	11	0.63	5.2	11.7
15% Vinyon—85% rayon	C.D.	12	0.43	4.0	27.0
15% Vinyon—85% cotton	C.D.	15	0.34	4.4	5.8
15% Vinyon—85% wool	C.D.	11	0.63	5.2	8.4
25% Vinyon—75% rayon	M.D.	12	0.47	4.0	63.1
25% Vinyon—75% cotton	M.D.	15	0.41	4.6	27.7
25% Vinyon—75% wool	M.D.	9	0.74	5.1	27.8
25% Vinyon—75% rayon	C.D.	12	0.54	4.7	49.0
25% Vinyon—75% cotton	C.D.	15	0.42	4.6	19.3
25% Vinyon—75% wool	C.D.	10	0.70	5.0	20.3

[a]M.D. = machine direction.
[b]C.D. = cross direction.

The application of silicone rubber mold release agents, or the use of Teflon (polytetrafluorethylene) on hot metal surfaces will reduce the probability of fiber sticking. Wrapping the hot metal rolls with glass fabric, or pressing between cellophane, has proved successful where such methods can be used.

Bonded Mats

Bonded fiber mats are being commercially produced successfully as 100% Vinyon, and in blends of from 5 to 95% with other fibers. In a blended fiber mat, the degree of flexibility, softness, resilience, strength, porosity, and other features may be controlled over a wide range depending upon the type of blending fiber used, the denier, length, and method of processing into the mat form, as well as upon the Vinyon itself and the bonding procedure used. As a general rule, rayon-Vinyon mats containing 5% to 25% activated Vinyon HH may be expected to attain approximately twice the strength of cotton-Vinyon or wool-Vinyon mats containing similar amounts of Vinyon HH. Mats containing 15 to 25% activated Vinyon HH blended with wool compare in strength with cotton mats of the same Vinyon content. Below 15% activated Vinyon HH, the cotton-Vinyon mats appear stronger than wool-Vinyon mats. Relative fiber strengths apparently serve an important function, as well as the amount of bonding. Some laboratory data indicating this relationship are given in Table IV.

Bonding Conditions

As has been mentioned, some pressure is essential to create a bond between the Vinyon and other fibers whether they be in yarn, mat, or fabric form. This may be little more than mere contact pressure of a few pounds per square inch in low density materials, or where strength is unimportant, to several thousand pounds per square inch for high density higher strength items. Pressures of 100 to 300 p.s.i. afford a good working range for bonding fibrous web materials and fabrics of 2 to 5 ounces per square yard.

Of greater influence is the temperature at which the material is pressed. An illustration of the effect of bonding temperatures on the strength of rayon-Vinyon fiber mats is given in Table V. These data, including that of Table IV, also afford a useful guide as to how changes in the Vinyon HH content may be expected to affect the strength of the material.

Table V. Effect of Temperature on the Bonding of Rayon-Vinyon Mats, 25% Vinyon HH—75% Rayon

Temperature, °F.	Thickness, mils	Density, g/cc.	Weight, oz./sq. yd.	Strength, lb./in.
194	13	0.44	4.3	2
203	13	0.43	4.2	5
212	10	0.55	4.1	10
230	11	0.51	4.2	15
257	12	0.63	5.7	25
275	12	0.47	4.2	63
194	13	0.47	4.6	14
203	14	0.48	5.0	19
212	11	0.56	4.6	25
230	10	0.69	5.2	35
257	7	0.70	3.7	45

Shrinkage

Being a thermoplastic fiber, Vinyon HH is repeatedly softened upon the reapplication of heat; and, if unrestrained, will exhibit considerable shrinkage. Likewise, with each succeeding application of an increased amount of heat, additional shrinkage takes place up through its melting range. The shrinkage of the staple as has been noted at various temperatures is given in Table VI.

If the Vinyon, either by itself or in blends with other fibers in the form of a fiber mat, yarn, or fabric, is subjected to heat, certain restraining forces are brought into play which resist the free movement of the staple, and the shrinkage at any given temperature may be appreciably less than is indicated in Table VI. If blended with wool and subjected to the felting procedure wherein the wool is shrunken and compressed, the shrinkage of the Vinyon may approach a maximum. On the other hand, if the Vinyon is blended with other fiber, spun into yarn, and woven, the restraining force of the other fibers in the yarn, or the fabric construction, may greatly retard the amount of shrinkage.

But little force is exerted by the UST Vinyon HH fiber in shrinking. Where maximum shrinkage is desired and some restraining forces are present, the use of MST Vinyon HH staple is suggested.

The shrunken and cooled fibers exhibit an increase in stiffness or loss of softness and flexibility that is related to the temperature and compressional forces to which they have been subjected. This stiffening is usually slight and is re-

Table VI. Vinyon HH Shrinkage

Temperature, °F.	Shrinkage, % UST	MST
140	0	0
160	18	..
165	27	..
175	45	60
185	50	..
195	55	..
212	60	75
230	65	..
250	70	..
270	Melting range	

Table VII

Vinyon HH spun yarn Fiber	Yarn size	Lea skein break, lb.	Single end break
3/1 1/2 in. Vinyon HH (MST)	14/1 c.c.[a]	36	5.5 oz.
3/1 1/2 in. Vinyon HH (UST)	15/1 c.c.	31	4.2 oz.
3/1 1/2 in. Vinyon HH (UST)	20/1 c.c.	21	3.3 oz.
50% Cotton 50% 3/1 in. Vinyon HH (UST)	25/1 c.c.	47	7.0 oz.
50% Cotton 50% 3/1 in. Vinyon HH (UST)	24/2/6 c.c.	..	7.2 lb.
85% 1 1/2/1 9/16 in. viscose 15% 3/1 1/2 in. Vinyon HH (UST)	25/1 c.c.	53.5	8.2 oz.
85% 1 1/2/1 9/16 in. viscose 15% 3/1 1/2 in. Vinyon HH (UST)	25/2/4 c.c.	..	6.2 lb.
25% Cotton 75% 3/1 in. Vinyon HH	25/1 c.c.	24	4.0 oz.
25% 1 1/2/1 9/16 in. viscose 75% 3/1 1/2 in. Vinyon HH (UST)	15/1 c.c.	56	7.7 oz.
90% 64's wool 10% 3/1 1/2 in. Vinyon HH (UST)	5 run w.c.[b]	..	8.4 oz.
80% 64's wool 20% 3/1 1/2 in. Vinyon HH (UST)	5 run w.c.	..	8.4 oz.
3/2 in. Vinyon HH (UST)	5 run w.c.	..	6.3 oz.
100% 64's wool	5 run w.c.	..	8.9 oz.
3/2 in. Vinyon HH (UST)	2 1/2 run w.c.	..	11.6 oz.

[a] c.c. = cotton count.
[b] w.c. = woolen count.

movable without injury to the fiber by flexing the material, if its tacky temperature has not been exceeded.

SPINNING

Due to the low strength and high extensibility of Vinyon HH staple, it has not been a very satisfactory fiber to spin into yarn. Static gives trouble in processing 100% Vinyon, but the application of certain finishes, such as Avcosol 104, and the use of static eliminators usually are effective in eliminating this. Loading on the card is also a problem with 100% Vinyon but has been fairly well controlled through the use of a fancy roll or continuous stripper. These remarks apply to the higher strength (0.8 g./d.) MST as well as regular (0.6 g./d.) UST Vinyon HH types. Less trouble and more uniform yarn is to be expected through use of the MST type. For cotton system use, the 3.0 denier 1 1/2 inch length is preferred.

Blending with 25 to 50% cotton or rayon for spinning on the cotton system is advisable, though 100% Vinyon HH yarn as fine as 20/1 c.c., has been made experimentally. The finest count spun in 50-50 blends with cotton has been 25/1 c.c.

The least trouble to be had in spinning Vinyon HH staple is on the woolen system. Two and a half and five run woolen spun Vinyon HH yarns of acceptable strength and quality have been spun on a commercial scale. Such yarns may be woven into filter fabrics of good chemical resistance and of superior filtering ability. They are also used for heat sealing purposes and where their shrinkage or contractual properties are of value.

Some characteristics of various spun Vinyon HH yarns are given in Table VII.

DYEING

While Vinyon HH staple may be stained, it has not been found practical to dye it 100% to deep shades possessing any reasonably good degree of wash fastness and light fastness. One or the other may be obtained with fair success using selected acetate dyes applied in a bath containing 5 to 6% Onyx Vinyon dyeing assistant or other swelling agent for Vinyon such as orthohydroxy diphenyl or dibutyl phthalate. It is well to paste up the dyestuff with Igepon and a little water. This paste should be stirred into hot water and the dispersion added to the water at 110°F. in the dye tank. The assistant is then added as the dyeing is started and the temperature raised to 130°F. Dyeing is continued for 1/2 to 3/4 hours depending upon how fast the shade develops. The stock is then given a light scour with Igepon at about 110°F. and rinsed. A finish is added if desired, to be followed by air drying.

For blending with wool to be after dyed acid colors, it is recommended the Vinyon first be dyed with Napthol dyes in the presence of an assistant and diazotized with acetic acid and sodium nitrite. The wool can then be brought up to shade in the wool acid dye bath.

Before attempting the dyeing of Vinyon with these or other dyestuffs, it is recommended that reference be made to the article on "The Dyeing of Vinyon" (*Am. Dyestuff Reporter*, April 22, 1946) by Jackson Woodruff of the Textile Research Department of American Viscose Corp.

Engineering Planning for Handling Mill Waste Waters

HARRY W. GEHM

Public consciousness over stream pollution has become aroused to an increasing degree over the past 15 years. Relatively little was done about it prior to this time except in cases where abatement was a dire necessity. When Federal funds became available to municipalities during the depression, sewage treatment programs occupied a high place among the public works projects undertaken. As a result tremendous strides were made in sewage pollution abatement in a very short period of time. This, together with the fact that the public now has more leisure time to enjoy recreational waters and the increasing need for water by growing population and industry has led to an increased demand for the control of industrial discharge. Conservation groups and government agencies have led the movement for stream pollution control. As a result most states now have either new or revised pollution control legislation. Groups of states have banded together for handling interstate problems and the Federal government has enacted a law broad in scope and power.

In order to deal with this problem most major industries have or are in the process of setting up organizations to study pollution problems, develop waste treatment, and recovery methods. In this activity the pulp and paper industry has been the leader. This is because of its need for vast quantities of water and a cooperative spirit in respect to its public responsibility arising through the fact that in many cases the paper mill is the sole industry in the community.

The industry's National Council for Stream Improvement has been developed to the point where it is set up to handle not only research and development work and maintain working relations with enforcement and other agencies having a proper interest in pollution abatement, but to offer direct and individual service to the mills and their engineers. The latter function has grown to major proportions and the activities include mill and stream surveys and projections, design of waste treatment and control works, and advisory service.

Inherent to every modern kraft pulp mill is a very efficient waste treatment system, since recoveries of over 95% of the residues cooked from the wood and the chemical employed are attainable. Coarser residues such as bark, rejects, and knots can be burned or recovered, and fiber loss held to a very low level. Hence, the water carried wastes produced are, under normal operating conditions, very dilute and relatively small in gravimetric quantity on the unit basis. Because of the large size of most kraft operations and the correspondingly great water requirement, the effluent from such mills is voluminous. The discharge of a 500-ton kraft mill is equivalent in volume to the sewage of a city of 100,000 people, and the waste water itself about the same strength in terms of oxygen demand and suspended solids as sanitary sewage.

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With these factors in mind, it appears obvious that under some conditions stream pollution problems could arise despite the high degree of waste reduction brought about by normal mill recovery and disposal facilities. This is particularly the case when the geographic location of the bulk of the kraft industry is considered. In the south some streams are often subject to wide variations in runoff, sluggish in velocity, and high in temperature. Other waterways are controlled in discharge to a high degree by power dams with too little regard to other uses.

The major objections to the discharge of kraft mill effluents in respect to the condition of receiving streams when dilution is low are as follows: oxygen depletion, unsightly floating matter, deposits of suspended matter, toxicity to fish, color, and odor.

The importance and seriousness of these vary greatly due to location, characteristics, and usage of receiving streams as well as mill design and operation. Oxygen depletion is the most common difficulty because of the relatively high oxygen demand load discharged by kraft mills. Depletion of the dissolved oxygen in a stream is objectionable mainly because it causes suffocation of fish. Toxicity is an important factor because of the presence of chemicals in the kraft process which in sufficiently high concentration in a stream can kill fish and microorganisms upon which young fish feed. Color is seldom a problem since most streams receiving kraft mill waste are either naturally colored, turgid, or dilution is sufficiently high so that the added color does not alter the normal color appreciably. However color is persistent and can be detected far below outfalls. Odor and taste problems have arisen in respect to streams receiving kraft effluents. This is a rare problem since few mills discharge into waters employed for potable or bathing purposes. It has been reported that fish removed from waters containing kraft effluent have a distinct taste associated with the odor of the mill. Careful tests conducted in Wisconsin under severe conditions failed to yield any evidence that taste could be imparted to the flesh of fish. Problems arising from floating material on surface waters and deposits of suspended matter on the bottom of water courses are fast disappearing due to the general application of better methods and equipment for fiber retention and for preventing bark, rejects, and other debris associated with pulping operations from reaching the sewer.

Of the 45 major kraft mills located in this country, about half are on large rivers or tidal waters which supply at all times adequate dilution to render the effluent innocuous. With regard to these units, none but very local problems can exist although these can generally be overcome by providing for rapid mixing of the waste with the receiving waters, retaining floating matter, and controlling unsightly foam. At least another quarter of the mills discharge into streams capable of diluting the waste to a degree wherein it does not alter the receiving waters to a degree rendering it unfit for the purposes to which it is put when the mill is operating normally. These mills can have difficulties during periods of upset, starting, shutdown, equipment failures, operational errors, and internal reconstruction work which correspond with low stream runoff. As a first preventive measure in cases of this kind, it is advisable to maintain the recovery system at peak efficiency. In order to do this intelligently, it is necessary to know the sources of liquor loss and their magnitude as well as points at which periodic losses occur. In order to be in a position to follow this properly, adequate facilities for continuously sampling and, where necessary, recording conductivity or pH of waste waters must be provided at strategic points in the system. It is strongly suggested that attention be given to segregation of sewers from each major mill unit and access be provided whereby flow measurement equipment and sampling devices can be installed properly. The following is a table of the desirable general divisions in respect to sewering together with the individual effluents involved.

1. Wood Preparation
   - Wash water
   - Rejects dewatering effluent
   - Floor drainings
2. Caustic Plant
   - Dregs
   - Slaker grit drainings
   - Overflows
   - Cooling waters
   - Floor drainings
3. Evaporator House
   - Barometric or surface condenser effluent
   - Jet condensers
   - Cooling water
   - Floor drainings
   - Washout tail water
   - Liquor storage overflows
4. Pulp Mill
   - Blowdown condensate
   - Relief condensate
   - Cooling water
   - Turpentine decanter water
   - Tall oil processing waters
   - Floor drainings
   - Overflows
   - Pulp wash water
5. Wet Room
   - Decker seal pit water
   - Cooling waters
   - Overflows
   - Floor drainings
6. Bleachery
   - Wash waters
   - Caustic extract
   - Overflows
   - Floor drainings
7. Machine Room
   - Machine water overflows
   - Saveall filtrates
   - Size tank washout
   - Cooling water
   - Overflows
   - Floor drainings
8. Power Plant and Water Treatment
   - Ash sluicing drainage
   - Cooling water
   - Boiler blowdown
   - Softener wash waters
   - Sedimentation tank blowdown
   - Filter wash water

Further segregation within these groups is often desirable with the thoughts in mind that (1) constantly weak wastes or cooling waters be segregated for separate discharge or reuse; (2) that high solids effluents such as dregs, grit, and ashes be lagooned; and (3) that constantly or periodically strong wastes be segregated with least dilution so that they may be lagooned or treated if necessary. Some of these separations are presently common practice. For example, slaker grit, dregs, and ash are generally conducted directly from the units producing them and deposited upon adjacent land, cooling waters collected and reused, and in some cases machine waters employed in the pulp mill or clarified for reuse elsewhere.

Process improvements have reduced the pollutional load of unbleached kraft pulp and paper mills in terms of oxygen demand from close to 300 to an average of 50 pounds per ton of production. Recent installations which have provided seasonal lagooning of segregated and periodically strong wastes have indicated the possibility of reducing this figure to below 25 pounds per ton for considerable periods without too costly or extensive holding basins.

In such an arrangement strong, low volume flows are carried directly to the lagoon. Large flows rising periodically in strength due to irregularities in operation are equipped with conductivity recorders and signal devices together with either manual or power operated diversion valves which switch the flow from the main sewer to a lagoon when desirable to do so. Mechanically operated valves can be arranged to operate automatically from the conductivity recorder so that diver-

sion in the proper direction occurs without attention of operating personnel.

Minor fluctuations in strength of the main sewer can be readily smoothed out by means of an equalizing tank, agitated mechanically or by recirculation having a detention period of about one half an hour.

Tank safety overflows and foam chambers can be directly connected to the lagoon sewer. In some cases pulp mill floor drams are treated likewise. However, where these are connected care must be taken to eliminate excessive use of washdown water so that limited storage capacity will not be rapidly depleted.

The advantages of waste segregation and lagooning of strong wastes is that this system provides the most economical method of reducing the load on the receiving stream seasonably after recovery facilities have been brought to maximum efficiency, and minimizes accidental discharge of slugs caused by equipment irregularities and failures.

In individual cases where the measures discussed above still do not suffice, treatment measures must be applied. Up to the present, only one method has been successfully applied for the treatment of this waste water. This is the clarification-oxidation lagoon system in operation at several southern mills. It has been demonstrated to be capable of reducing the suspended solids content of the waste to an insignificant concentration, reducing the oxygen demand of the waste from 30 to 70% during warm weather, and eliminating all possibility of potentially toxic substances from reaching the stream in significant concentration. It is not effective in removing color but does reduce taste and odor potentialities considerably. The major limitations of the process are the large lagoon areas required, the necessity for disposing of voluminous residues resulting from clarification, and the fact that the biological action responsible for the oxygen demand reduction operates at a high rate only at relatively high temperatures. The latter limits its use to the south.

Research conducted for the purpose of developing better and more widely applicable methods has followed two lines of approach. These are: (1) biological treatment at higher efficiencies requiring more compact systems than those presently employed, and (2) chemical treatment systems allowing integration with the pulp mill recovery system.

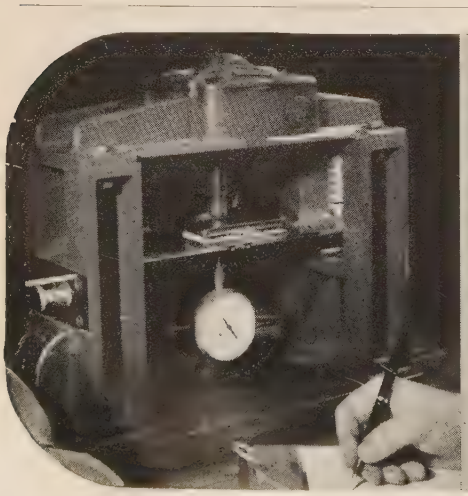
These studies are now being carried on by a number of mills in cooperation with the National Council for Stream Improvement's projects at L.S.U. and the Institute of Paper Chemistry and their status summarized as follows:

After a comprehensive investigation of the numerous factors which were believed to affect the rate of biological oxidation of kraft mill waste, laboratory experiments have indicated that the most important of these is the presence of sufficient nitrogen and phosphorous, adequate seeding, and the elimination of anaerobic conditions prevailing in the wastes as discharged. Actual tests have indicated that an extremely high degree of B.O.D. reduction could be obtained if 5 p.p.m. of nitrogen and 1 p.p.m. of inorganic phosphorous were added to combined mill wastes, 100 p.p.m. of seed sludge added, and the mixture aerated for relatively short periods of time. It was also demonstrated that if pretreated in this manner for a very short period, oxidation on subsequent storage would proceed with much greater rapidity than if pretreatment were omitted. It appears, therefore, that possibly a workable process is at hand combining a small preconditioning unit and lagooning for short detention periods as compared to the large and long storage requirement procedure necessary without such preconditioning. It now appears that development work on the pilot plant scale is necessary to determine more fully the optimum process requirements and its ability to operate under actual mill effluent conditions.

Following laboratory studies of the treatment of combined kraft mill waste and bleachery waste by a lime recarbonation method, which appeared promising, pilot plant studies were made at a southern mill to prove this process further. In this system the residues obtained would be burned in the recovery plant lime kiln and the lime content recovered. Results of the pilot plant work indicated that almost complete color and suspended solids removal, as well as from 30 to 70% B.O.D. removal, can be obtained on kraft mill wastes by this method of treatment. The degree of B.O.D. removal depends, to a large extent, on the initial concentration. Contrary to results obtained in the laboratory, difficulties were encountered in dewatering the sludge obtained. This was believed to be caused by the lack of satisfactory control indices. Hence, this process has been taken back to the laboratory for the purpose of developing the necessary control methods and improving on the technique of application of the process in general in the hope of overcoming this difficulty.

In summarizing the above it can be stated that the major pollution problems of kraft mills consist mainly of oxygen depletion in receiving streams at low runoff. Increased efficiency of recovery systems has reduced the pollutional load of kraft mills to a point where, when in normal operation, the 5-day oxygen demand load averages about 50 pounds per ton of production. This loading can be reduced seasonally better than 50%, the danger of shock loads reduced, and checks maintained on operation of the recovery system by suggested sewer segregation and the use of a relatively small diversion lagoon and accessory equipment. Further reduction can be obtained at present by the use of oxidation lagoons. These, however, are limited in application because of the large size required. Research is at present directed toward developing more universally applicable treatment techniques.

Received July 15, 1950. Presented at the Fifth Engineering Conference sponsored by the Technical Association of the Pulp and Paper Industry, Cincinnati, Ohio, Oct. 2–5, 1950.



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BIBLIOGRAPHY ON RESIN ANALYSIS

Contribution from the Subcommittee on Resin Analysis of the Plastics Committee of TAPPI

Compiled by ELMER V. SMITH and T. P. G. SHAW

Papers dealing with more than one resin are listed under the general heading. Instrumental methods, as they are not generally available, have been listed separately. It has been our purpose to include papers relating to analysis or properties if we thought they might have even a remote possibility of aiding in the detection of a resin or resins which might be encountered in the paper field.

The literature search covered by this work encompassed *Chemical Abstracts* completely and an extensive library of books on plastics.

It was found more or less impossible to list every specific resin covered by every paper, particularly so as in most cases only the abstract was available.

A few papers believed to be outstanding are indicated by an asterisk.

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Gerber, R., and Lathrop, K., Qualitative identification and quantitative estimation of nylon in the presence of silk, wool, and cotton *C. A.* 34: 7113[5] (*Am. Dyestuff Reptr.* 29: 437–440 (1940)).

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Study of fluorescent color of pitches.

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Millson, H. E., The phosphorescence of textile fibers and other substances, *C. A.* 38: 1883[8] (*Textile Colorist* 65: 495–497, 503–506 (1943)).
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Miscellaneous Resins and Separation and Purification

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Yelton, E. B., Teflon—new resin with unusual properties, *C. A.* 40: 4909[1] (*Plastics and Resins* 5, no. 5: 14–16, 36 (1946)).
Properties of teflon.

Refining manila copal, *C. A.* 35: 3466[6] (*Philippine J. Sci.* 73: 285–291 (1940)).
A method for refining crude copal.

Ross, J., Resin purification, *C. A.* 39: 3169[2] (U. S. pat. 2,369,409 (Feb. 13, 1945)).
Particularly directed at rosin products.

UNITED STATES PATENTS ON PAPERMAKING

Fourth Quarter, 1950 — *Compiled by CLARENCE J. WEST*

The following list of patents has been compiled from the current numbers of the Official Gazette of the United States Patent Office. Because, as a rule, only one claim is published in the Gazette, it is not claimed that the list is complete; also, it is possible that the list may contain some patents that do not apply specifically to pulp and paper manufacture.

Copies of any of the following patents can be obtained from the United States Patent Office, Washington 25, by sending twenty-five cents for each patent desired.

October 3, 1950

2,524,030. Method of closing bag tube ends. Henry H. Allen, assignor to Bemis Bro. Bag Company, Minneapolis, Minn. Filed May 28, 1945. 3 claims. (Cl. 229-62.) A method of closing and sealing an open bag top with a strip of tape.

2,524,032. Sealing method for cartons. Leonard Back, Middletown, Ohio, assignor to The Interstate Folding Box Company. Filed June 7, 1945. 10 claims. (Cl. 93-6.) A method of sealing the end flaps of cartons with the aid of a metal strip or plate.

2,524,078. Device for filing and method therefor. Rudolf J. Priepke, South Brunswick Township, Middlesex County, N. J. Filed Sept. 18, 1946. 3 claims. (Cl. 229-23.) A method of filing unbound periodicals and the like with board sleeves.

2,524,133. Device for forming paper boxes. John F. Pagendarm, assignor to Bemiss-Jason Company, Oakland, Calif. Filed Jan. 22, 1945. 15 claims. (Cl. 93-51.) A machine is proposed for the automatic interlocking of the sides and ends of a tray-type box (for bakery products).

2,524,152. Folding box and handle therefor. Alvin Whittaker, North Hollywood, Calif. Filed Oct. 8, 1946. 1 claim. (Cl. 229-52.) A one-piece lock corner box, with a handle attached to one front by spring clips.

2,524,344. Means for forming the corners of paper box cover blanks. Carl W. English, Charlotte, N. C. Filed Nov. 18, 1947. 11 claims. (Cl. 164-59.) An apparatus for diagonally cutting away the outer corners of the end and side flaps of a box shell covering blanks.

2,524,345. Packaging and displaying device. Manuel Essman, New York, N. Y. Filed April 24, 1948. 4 claims. (Cl. 206-80.) A cardboard mounting element for neckties.

2,524,411. Carton. Reynolds Guyer, assignor to Waldorf Paper Products Company, St. Paul, Minn. Filed July 31, 1946. 2 claims. (Cl. 229-43.) A carton is provided with two opposed side walls which are of double thickness and with closure flaps integral with the walls which are also of double thickness.

2,524,516. Shipping and display box. Richard J. Cody, assignor to Federal-Mogul Corporation, Detroit, Mich. Filed Jan. 28, 1948. 1 claim. (Cl. 229-28.) A partitioned board carton is adapted for the packaging of automobile crankshaft bearing shells.

2,524,517. Bottle carrier. Arthur E. Cole, assignor to National Folding Box Company, Inc., New Haven, Conn. Filed May 1, 1948. 3 claims. (Cl. 224-45.) A multicompartment bottle carrier is hinged at one end.

October 10, 1950

2,524,753. Method of recovering heat and suspended chemical particles from gases resulting from the combustion of a pulp residual liquor and apparatus therefor. Joseph L. Betts, Mobile, Ala. Filed Jan. 10, 1946. 8 claims. (Cl. 23-48.) A method of recovering heat and chemicals from the recovery furnace for kraft black liquors.

2,524,766. Container. Joseph P. Carroll, assignor to American Can Company, New York, N. Y. Filed Nov. 14, 1946. 2 claims. (Cl. 229-5.5.) A liquidproof fiber container.

2,524,816. Method of improving kaolin and products thereof. Sanford C. Lyons, assignor to Bird Machine Company, Walpole, Mass. Filed Feb. 21, 1946. 10 claims. (Cl. 23-110.) By a controlled precipitation, a coating clay is obtained in which the particle sizes range from 0.25 to 3 mu.

2,524,964. Hydraulic apparatus for pulsating the diaphragms of pulp mill screens. Frank Dustan, assignor to National Lead Company, New York, N. Y. Filed July 11, 1945. 1 claim. (Cl. 121-41.) The apparatus is so constructed that there are very short paths for the flow of the hydraulic fluid between the control valve and the power cylinder.

2,525,071. Laminated sheet material and compositions. Paul E. Hardy and William J. Sparks, assignors to Standard Oil Development Company, New York, N. Y. Filed Nov. 30, 1945. 9 claims. (Cl. 154-50.) A paper sheet carries a styrene-isobutylene copolymer which contains from 20 to 60% by weight of powdered sodium montmorillonite (at least 95% through a 100-mesh screen).

2,525,125. Cell type carton. Charles H. Goodyear, assignor to Fibreboard Products, Inc., San Francisco, Calif. Filed March 12, 1948. 4 claims. (Cl. 229-28.) A lidless, tray-type carton suitable for the packaging of nectarines, peaches, plums, or tomatoes.

2,525,139. Pouch making machine. Harry W. Ligon, assignor to Atlanta Paper Company, Atlanta, Ga. Filed March 4, 1946. 1 claim. (Cl. 93-8.) A method of forming paper pouches by sealing two strips of paper along three sides.

2,525,146. Selective separation by flotation of phosphatic titanium-oxide mixtures. Lynn L. McMurray and Samuel P. Moyer, assignors to American Cyanamid Company, New York, N. Y. Filed Dec. 20, 1945. 11 claims. (Cl. 209-167.) A conditioning agent consists of 3.75 pounds of starch caustic (22 parts of caustic to one part of starch) and 0.58 pound of tall oil per ton of flotation feed.

2,525,214. Microbiological processes. Sigvard F. A. Ekelund, Halmstad, Sweden. Filed July 9, 1947. 8 claims. (Cl. 195-28.) A method is described for fermenting sulphite waste liquor by yeast to yield ethyl alcohol.

2,525,268. Carton structure. Archibald S. Napier, St. Paul, Minn. Filed July 18, 1947. 12 claims. (Cl. 229-34.) A tray-type carton is provided with a corner lock; one lock can be provided at each corner of the carton.

2,525,310. Method of producing paper base plastic sheet material. Izador J. Novak, assignor to Raybestos-Manhattan, Inc., Passaic, N. J. Filed Nov. 30, 1944. 6 claims. (Cl. 154-138.) Sulphite or soda paper is impregnated with urea- or melamine-formaldehyde resin (30 to 60% of resin by weight) and dried at 190 to 212°F.; the heat is applied alternately to the two sides of the web, thus alternating the direction of vapor flow through the web.

2,525,345. Machine for rupturing paper and the like for testing purposes. Raymond E. Getchell, assignor to B. F. Perkins & Son, Inc., Holyoke, Mass. Filed May 20, 1948. 2 claims. (Cl. 73-102.) A means is claimed for clamping the specimen in a bursting strength tester.

2,525,433. Inks. Andries Voet, assignor to J. M. Huber Corporation, Locust, N. J. Filed Sept. 23, 1947. 19 claims. (Cl. 106-30.) The ink contains from one to five parts of lignin for each part of pigment.

2,525,594. Deinking waste paper. Francis L. Fennell, assignor to E. I. du Pont de Nemours & Company, Wilmington, Del. Filed March 6, 1947. 3 claims. (Cl. 92-1.5.) The waste paper is treated for one to two hours at 140 to 160°F. with 0.25 to 3% of sodium peroxide and 2 to 8% of sodium hydroxide (each on the dry weight of the paper).

2,525,600. Tension control device. Lloyd Hornbostel, Beloit, Wis. Filed Jan. 29, 1944. 11 claims. (Cl. 242-75.) A rewinder incorporates a very sensitive dance roll assembly which actuates an automatic brake control on the unreeling stand supplying the rewinder.

2,525,686. Collapsible compartmented carton with handle. Michael H. Kowal, assignor to Empire Box Corporation, Garfield, N. J. Filed Jan. 27, 1950. 3 claims. (Cl. 229-52.) The construction of a compartmented cardboard bottle carrier is claimed.

2,525,690. Folding box. Morris Lazow, Brooklyn, N. Y. Filed July 3, 1948. 2 claims. (Cl. 229-41.) A folding box for packaging individual ice cream sandwiches.

2,525,701. Pulp screen. Wilfred F. Mathewson, assignor to Mathewson Machine Works, Inc., Quincy, Mass. Filed Dec. 10, 1948. 3 claims. (Cl. 92-35.) The screening means consists of two concentric cylindrical screens separated by an annular clearance space which permits the passage of the acceptable stock.

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2,525,863. Coating and laminating apparatus. Edward J.

Carter, assignor to William M. Scholl, Chicago, Ill. Filed Jan. 29, 1947. 7 claims. (Cl. 154-37.) The apparatus if for coating and impregnating a liquid-permeable sheet or tape material (paper or textile) with a liquid composition. Adjustable tensioning means compress a layer of coating composition between two webs to force the liquid through the upper of the two webs.

2,525,864. Method of making adhesive tape. Edward J. Carter, assignor to William M. Scholl, Chicago, Ill. Filed Aug. 7, 1947. 2 claims. (Cl. 18-59.) Method of forming pressure-sensitive tape.

2,585,888. Closure for containers. Marjorie Freeman, St. John, Wash. Filed May 9, 1947. 1 claim. (Cl. 229-43.) A closure for a container consists of a cover which is slidably mounted between a pair of guide edges and which has an outwardly extending, metallic arm.

2,525,892. Refining tall oil. Louis E. Gates and Lee A. Radeker, assignors to The Champion Paper and Fibre Company, Hamilton, Ohio. Filed March 12, 1947. 6 claims. (Cl. 260-97.7.) Tall oil is mixed with 0.5% orthophosphoric acid or its acid salts, heated to 280 to 330°F., and treated with steam or other nonoxidizing gas until the mixture is free of sulphides.

2,526,052. Shipping container with provision for protecting corners of contents. Samuel Stimmel, Bronx, N. Y. Filed June 19, 1948. 5 claims. (Cl 229-87.) A one-piece shipping container for electroplates or lithographed displays.

2,526,076. Washcloth, dishcloth, scouring cloth, and the like, and method of making the same. Harold H. Jones, assignor to Kalamazoo Vegetable Parchment Company, Parchment, Mich. Filed March 7, 1946. 5 claims. (Cl. 15-209.) The product is formed of a sheet of parchmentized paper.

2,526,083. Method of fireproofing chlorophyll containing materials. Morris L. Nielsen, assignor to Monsanto Chemical Company, St. Louis, Mo. Filed July 30, 1948. 3 claims. (Cl. 117–138.) A fireproofing agent for boards consists of 56% of borax, 24% of boric acid, and 20% of diammonium phosphate.

2,526,125. Paper products and methods of making the same. Carleton S. Francis, Jr., assignor to American Viscose Corporation, Wilmington, Del. Filed May 25, 1942. 8 claims. (Cl. 92-21.) In the manufacture of board from waste paper, 15% of fibers of a copolymer of 90% vinyl chloride and 10% vinyl acetate is added to the beater; a sheet about 0.5 inch thick is formed from a vat and the wet sheet is subjected to a pressure of 300 p.s.i. without the application of heat; it is then dried at about 160°.

2,526,157. Apparatus for heat exchange between liquids. Torsten Ramén, Stockholm, Sweden. Filed June 14, 1945. 1 claim. (Cl. 257-245.) The unit consists of a rectangular, elongated casing into which a number of hollow, flat, parallel elements are inserted; one of the liquids flows through the hollow conduits and the other passes through the spaces between the conduits.

2,526,185. Folded fibrous material product. Norval F. Wilson, assignor to Alton Box Board Company, Alton, Ill. Filed June 3, 1944. 4 claims. (Cl. 40-125.) An automobile license plate is formed of paper, cloth, or a combination of the two.

2,526,189. Moisture removing apparatus. Ralph L. Atkinson and Edward J. Hopkins, assignors to United Wallpaper, Inc., Chicago, Ill. Filed April 15, 1946. 4 claims. (Cl. 263-3.) A method is claimed for the drying of webs of wallpaper.

2,526,330. Cellulose acetate coated dielectric paper for electrical devices. Frank M. Clark, assignor to General Electric Company, Schenectady, N. Y. Filed March 1, 1946. 2 claims. (Cl. 174-113.) A dielectric material comprises a sheet of kraft paper (density of 0.85 to 1.1) which is coated on both sides with cellulose acetate film (0.00001 to 0.001 inch in thickness).

2,526,598. Process for preparing coating color. William H. Barrett and Edgar Zimmerman, assignors to Minnesota and Ontario Paper Company, Minneapolis, Minn. Filed Nov. 2, 1942. 4 claims. (Cl. 106-137.) A mixture of adhesive, pigment, and water is passed through a channel in which it is subjected to high shearing and centrifugal forces, after which the mixture is heated to 160–180°F.

2,526,605. Gasket material. George L. Fraser, assignor to Monsanto Chemical Company, St. Louis, Mo. Filed Dec. 4, 1948. 4 claims. (Cl. 117-140.) An uncalendered alpha-cellulose sheet is impregnated with a mixture of 25 to 100 parts diallyl phthalate and 100 parts of a polyester and cured by heat.

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2,526,638. Paper treated with formaldehyde and a polymeric polyamine. Martin E. Cupery, assignor to E. I. du Pont de Nemours & Company, Wilmington, Del. Filed March 3, 1949. 5 claims. (Cl. 117-155.) A waterproof kraft paper results on treatment with 20 parts of polyamine solution (prepd. by reductive amination of polyketones) and one part of 37% formaldehyde and heating one hour at 105°C.

2,526,787. Laminated cellulosic fabrics. Richard H. Wiley, assignor to E. I. du Pont de Nemours & Company, Wilmington, Del. Filed Jan. 22, 1945. 6 claims. (Cl. 154-138.) Paper or board is coated with magnesium or zinc fluosilicate and then laminated with sodium silicate.

2,527,025. Container. Leo Morgan, Toronto, Ontario, Canada. Filed Sept. 11, 1948. 2 claims. (Cl. 224-45.) A bottle carrier is formed of a single sheet of cardboard stock which may be coated or impregnated with wax or other suitable material to render it moistureproof.

2,527,028. Display container. Harold L. Myers, Morristown, N. J. Filed July 8, 1948. 6 claims. (Cl. 206-45.) The construction of the container is described.

2,527,073. Bag closure. Richard A. Port, assignor to International Paper Company, New York, N. Y. Filed June 3, 1947. 4 claims. (Cl. 229-66.) A multiwall paper bag of the offset or notch-corner type is described in which the major portion of the bag end is closed by a transverse line of stitching.

2,527,074. Bag closure. Richard A. Port, assignor to International Paper Company, New York, N. Y. Filed Oct. 15, 1947. 3 claims. (Cl. 229-66.) A method of closing (by stitching) of a multiwall paper bag is claimed.

2,527,167. Carton. George E. Waude, assignor to Marathon Corporation, Rothschild, Wis. Filed Oct. 15, 1947. 2 claims. (Cl. 229-36.) A carton for frozen foods includes a tray portion and a hinged cover.

2,527,221. Multicompartment box. Joseph G. Huye, assignor to Huye Space Saving Box System, Inc., New Orleans, La. Filed July 31, 1945. 4 claims. (Cl. 229-15.) A ventilated chick box.

2,527,295. Apparatus for manufacturing valve bags. Daniel Belcher, Russell J. Williams, and James E. Voege, assignors to Bemis Bro. Bag Company, St. Louis, Mo. Filed June 25, 1947. 38 claims. (Cl. 93-8.) Apparatus for manufacturing gusset-side valve bags.

2,527,478. Bottle carrier. Harry Z. Gray, Lebanon, Ohio. Filed March 4, 1940. 4 claims. (Cl. 224-45.) The formation of a bottle carrier from a one-piece blank is described.

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2,527,563. Method of bleaching semichemical pulps. Robert L. McEwen, assignor to Buffalo Electro-Chemical Company, Inc., Tonawanda, N. Y. Filed Aug. 13, 1947. 1 claim. (Cl. 8-106.) Semichemical pulps containing from 7 to 17% lignin is treated with 0.25 to 1% active chlorine at a pH of 3.5 to 9 and then bleached with an alkaline peroxide.

2,527,685. Package wrapper. John H. Riush, Johnson County, Kan. Filed Sept. 6, 1946. 1 claim. (Cl. 229-40.) A paper wrapper is adapted for books, paper, and the like.

2,527,692. Package construction. Edward D. Andrews, assignor to The Quaker Oats Company, Chicago, Ill. Filed Dec. 1, 1948. 2 claims. (Cl. 229-14.) A container for breakfast cereals consists of an open-end cardboard sleeve enclosed in a moisture-resistant wrapper.

2,527,701. Cellular carton. Kenneth T. Buttery, assignor to Sutherland Paper Company, Kalamazoo, Mich. Filed Aug. 2, 1946. 6 claims. (Cl. 229-28.) A multicompartment carton is designed as a display package for bakery products and fruit.

2,527,702. Cellular carton. Kenneth T. Buttery, assignor to Sutherland Paper Company, Kalamazoo, Mich. Filed Aug. 22, 1946. 10 claims. (Cl. 229-28.) A multicompartment carton for bakery products incorporates transverse partitions to support the side walls.

2,527,705. Paperboard box. Jay D. Crary and Harry M. Mathers, assignor to Paper Strap, Inc., Portland, Ore. Filed May 27, 1946. 1 claim. (Cl. 229-45.) A box for cakes, pies, and other bakery products.

2,527,752. Apparatus for building up structural elements from paper sheets. George May, assignor to Dufay-Chromex Ltd., London, England. Filed Sept. 8, 1947. 7 claims. (Cl. 154-1.) This is a continuation of U. S. patent 2,428,979 (Oct. 14, 1947) and relates to the construction of doors, wall, and the like from paper.

2,527,772. Pulping machine. Stephen G. Stapley and William Subart, assignors to E. D. Jones & Sons Company, Pittsfield, Mass. Filed May 6, 1947. 4 claims. (Cl. 92-26.) The original Stapley pulper (U. S. patent 2,433,490, Dec. 30, 1947) is modified.

2,527,784. Vegetable box. Ralph E. Acker, assignor to Container Corporation of America, Chicago, Ill. Filed April 14, 1950. 2 claims. (Cl. 229-16.) A ventilated corrugated board container.

2,527,793. Hot melt coating compositions. Charles K. Bump and George H. Bischoff, assignors to Monsanto Chemical Company, St. Louis, Mo. Filed Feb. 28, 1948. 5 claims. (Cl. 260-23.) A typical composition contains 100 parts polyvinyl butyral, 160 parts hydrogenated castor oil, 150 parts stearamide, 60 parts butyl benzyl phthalate, 260 parts ester gum, and 5 parts dimethylsilicone polymer.

2,527,856. Hot melt composition. George R. Sido and John F. Murphy, assignors to Monsanto Chemical Company, St. Louis,

Mo. Filed July 14, 1948. 9 claims. (Cl. 260-23.) The composition contains 100 parts polyvinyl butyral, 260 parts hydrogenated castor oil, 360 parts esterified polymerized rosin, 27 parts dioctyl phthalate, and 27 parts of the methyl ether of a *p*-toluenesulfonamide-formaldehyde condensation product.

2,527,925. Envelope. John A. Frampton, Columbus, Ohio. Filed Nov. 20, 1946. 3 claims. (Cl. 229-73.) An envelope is designed to be used for third-class mail and then as first-class mail.

2,528,005. Electrosensitive recording blank. Bernard L. Kline, assignor to The Western Union Telegraph Company, New York, N. Y. Filed May 14, 1948. 6 claims. (Cl. 204-2.) An electrically conductive (impregnated with an electrolyte or by addition of a finely divided metal powder or carbon), highly calendered paper is coated with cuprous thiocyanate.

2,528,016. Folded partitioned tray with transparent wrapper. Charles S. Smith, Arlington, Va. Filed March 19, 1946. 7 claims. (Cl. 206-45.33.) A cardboard box has an interior wall or walls which form a compartment for edible products.

2,528,152. Method and apparatus for producing resin-impregnated sheets. Stephen V. Landgraf, assignor to United States Rubber Company, New York, N. Y. Filed June 24, 1947. 8 claims. (Cl. 154-37.) A continuous method for the production of a resin-impregnated sheet which has a mar-resistant outer surface.

2,528,189. Apparatus for the manufacture of paper. John Temperley, assignor to Walmsleys (Bury) Ltd., Bury, England. Filed Nov. 27, 1945. 6 claims. (Cl. 92-43.) A main stream of paper pulp is directed around substantially the major portion of the immersed part of a cylinder in a stock vat and a number of separate and individually adjustable auxiliary streams of liquids are directed into the main stream at a number of spaced points and in contraflow thereto.

2,528,251. Receptacle. Percy L. Spencer, assignor to Raytheon Manufacturing Company, Newton, Mass. Filed March 8, 1947. 1 claim. (Cl. 229-51.) A protective wrapper (e.g., waxed paper) is adapted for the packaging of foods which are to be heated in a microwave heating apparatus.

2,528,256. Egg case. Harold D. Tichenor, assignor to Wabash Fibre Box Company, Terre Haute, Ind. Filed June 7, 1948. 1 claim. (Cl. 229-39.) The formation of an egg case from two sheets of corrugated board is described.

2,528,324. Method of treating paper and the resulting products. Richard Thomas, assignor to Lever Brothers Company, Cambridge, Mass. Filed April 10, 1946. 10 claims. (Cl. 117-33.5.) A whitening effect is obtained by adding to the paper 0.0001 to 0.025% of an aminoaroylaminostilbenesulfonic acid.

2,528,332. Self-acting closure. Carl G. Bergquist, assignor to Electrolux Corporation, Old Greenwich, Conn. Filed July 3, 1947. 4 claims. (Cl. 229-43.) A receptacle closure is designed for use as a self-closing mouth for a dust-separating receptacle for tank-type vacuum cleaners.

2,528,344. Adjustable cam mechanism. William L. Davis, assignor to Union Bag & Paper Corporation, New York, N. Y. Filed July 17, 1948. 7 claims. (Cl. 74-568.) An adjustable cam mechanism is used in conjunction with the opening cylinder assembly of a paper bag making machine to vary the axial and radial movements for different size bags.

2,528,349. Alkaline sulphite digestion of hardwood. Eduard Farber, assignor to Hardwood By-Products, Inc., Asheville, N. C. Filed Feb. 27, 1945. 3 claims. (Cl. 92-13.) Hardwoods are treated at atmospheric pressure and 40 °C. with a solution containing 0.5% each of sodium hydroxide and sodium sulphite.

2,528,350. Two-step digestion of hardwoods. Eduard Farber, assignor to Hardwood By-Products, Inc., Asheville, N. C. Filed June 5, 1947. 4 claims. (Cl. 92-13.) The hardwood particles are digested for one or two hours at 15 to 30 °C. in 0.4 to 2.5% aqueous sodium sulphite and then for one or two hours at 70 to 80 °C. with 1 to 4% aqueous sodium hydroxide.

2,528,351. Alkaline sulphite digestion of hardwood. Eduard Farber, assignor to Hardwood By-Products, Inc., Asheville, N. C. Filed Aug. 17, 1950. 2 claims. (Cl. 92-13.) Hardwood is treated for one or two hours at 55 to 75 °C. with an aqueous solution containing up to 4% of an alkali hydroxide and up to 2.5% of an alkali sulphite.

2,528,413. Method of making pallets. Larry J. Budd, assignor to Pallet Devices, Inc., Melrose Park, Ill. Filed July 14, 1948. 9 claims. (Cl. 93-1.) A pallet consists of a rectangular platform of 60-point kraft board supported on short columns of thick-walled paper tubing.

2,528,419. Bag valve. Edwin E. Burroughs, assignor to St. Regis Paper Company, New York, N. Y. Filed July 30, 1948. 4 claims. (Cl. 229-62.5.) A multi-ply, gusseted, sewn-end valve bag incorporates a supplemental sheet in its valve arrangement.

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2,528,603. Container. Richard W. McDermott, assignor to National Folding Box Company, Inc., New Haven, Conn. Filed Nov. 16, 1945. 6 claims. (Cl. 229-37.) A radio tube carton.

2,528,713. Paper reeling method and apparatus. William R. Thomson, Ottawa, Ontario, Canada. Filed Dec. 21, 1946. 10 claims. (Cl. 242-65.)

2,528,715. Refrigerated shipping container. George B. Wagner, assignor to Beekman Industries, Inc., New York, N. Y. Filed Feb. 6, 1947. 11 claims. (Cl. 62-91.5.) A container for shipping live lobsters.

2,528,803. Preparation of metallic soaps. Gilbert G. Unkefer, assignor to The Harshaw Chemical Company, Cleveland, Ohio. Filed Aug. 1, 1947. 6 claims. (Cl. 260-97.5.) Tall oil and its acids yield metallic salts when boiled with the metal in alcohol containing acetic acid.

2,528,830. Powdered soap container. Kathryn C. Iliff, Kansas City, Mo. Filed Oct. 21, 1946. 1 claim. (Cl. 229-11.)

2,528,900. Construction of containers. Reginald B. Meller, assignor to Bemiss-Jason Company, Oakland, Calif. Filed Feb. 26, 1945. 7 claims. (Cl. 229-35.) A carton for the packaging of loose bulk products (e.g., potato chips).

2,528,936. Method of polymerizing nonwrinkling oils to wrinkling oils. Gordon M. Williams, assignor to New Wrinkle, Inc., Dayton, Ohio. Filed April 9, 1947. 11 claims. (Cl. 106-222.) A vegetable oil is heated with a small quantity of finely divided copper at 150 °C. for approximately three hours.

2,528,937. Wrinkling oils. Gordon M. Williams, assignor to New Wrinkle, Inc., Dayton, Ohio. Filed April 9, 1947. 6 claims. (Cl. 106-222.) A vegetable fatty oil (100 parts) and 0.05 part of sodium is heated at 120 °C.

2,529,060. Self-sealing wrapping material. Bertram L. Trillich, assignor to The Munising Paper Company, Chicago, Ill. Filed Nov. 7, 1949. 9 claims. (Cl. 117-43.) One surface of a calendered paper is coated with a wax and the other with a non-adhesive rubber.

2,529,128. Carton and method of making it. Robert M. Bergstein, Cincinnati, Ohio, assignor to R. M. Bergstein and Frank Bergstein, trustees. Filed Aug. 6, 1945. 3 claims. (Cl. 229-23.) A carton has a window of cellulose acetate which is a true structural component of the box.

2,529,140. Carton. John W. Cox, assignor to Shellmar Products Corporation, Chicago, Ill. Filed Nov. 22, 1947. 10 claims. (Cl. 229-2.5.) A molded pulp egg carton.

2,529,147. Carton, William P. Frankenstein, Cincinnati, Ohio. Filed Feb. 27, 1945. 13 claims. (Cl. 229-34.) A foldable cardboard carton for multidiameter articles.

2,529,184. Web threader for winder machines. Charles M. Pearson, assignor to The Bagley & Sewall Company, Watertown, N. Y. Filed Sept. 15, 1949. 5 claims. (Cl. 242-66.) A web threading device for drum winders.

2,529,288. Container for carbon paper and similar sheet material. Frederic H. Gibson, Westwood, N. J., assignor of one half to Fred H. Mahler, Bronx, N. Y. Filed June 13, 1947. 2 claims. (Cl. 206-62.)

2,529,335. Preparation of a heat insulating material from peat. John G. Helland and Ragnar E. L. Moen, Skien, Norway. Filed Dec. 29, 1947. 2 claims. (Cl. 92-9.) A method of washing and drying peat to form a heat-insulating material.

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2,529,595. Shipping and display box. Richard J. Cody, assignor to Federal-Mogul Corporation, Detroit, Mich. Filed Jan. 28, 1948. 1 claim. (Cl. 229-28.) A carton adapted for the packaging and display of crankshaft bearing shells.

2,529,675. Construction of cartons. Laurence W. Brulin, New York, N. Y. Filed Sept. 8, 1948. 2 claims. (Cl. 229-52.) A method of forming a carton with a comparatively high structural strength when constructed with a relatively light cardboard.

2,529,699. Apparatus for coating paper with carbon wax. John Lach, Chicago, Ill., assignor to Uarco, Inc. Filed Sept. 12, 1947. 4 claims. (Cl. 91-30.) An apparatus is provided for the application of a uniform coating of carbon wax to one side of a thin paper web.

2,529,725. Bottle carton. Grover C. Currie, assignor to Dacam Corporation, Charlotte, N. C. Filed Sept. 10, 1948. 3 claims. (Cl. 229-52.) A bottle carrier has hand holes in each of its end walls.

2,529,732. Container forming machine. Stanley R. Howard, assignor to Pneumatic Scale Corporation, Ltd., Quincy, Mass. Filed April 15, 1947. 17 claims. (Cl. 154-42.) A machine for forming tea bags.

2,530,026. Apparatus for saturating edge portions of fiberboards. Carl G. Muench, assignor to The Celotex Corporation, Chicago, Ill. Filed Oct. 25, 1945. 4 claims. (Cl. 91-43.)

2,530,122. Web guide. Lloyd Hornbostel, assignor to Beloit Iron Works, Beloit, Wis. Filed May 26, 1948. 6 claims. (Cl. 74-241.) A web guide is designed to retain a papermaking felt or wire in proper alignment as it travels over supporting rolls.

2,530,124. Nested cup. Robert J. Kieckhefer, assignor to American Lace Paper Company, Milwaukee, Wis. Filed May 29, 1944. 5 claims. (Cl. 229-2.5.) A method of forming a stack of nested molded-pulp cups.

2,530,181. Separating apparatus. Frederick B. Schilling, assignor to Nichols Engineering & Research Corporation, New York, N. Y. Filed July 29, 1947. 1 claim. (Cl. 209-211.) A vortex-type separator for pulp is provided with a rotary valve mechanism in combination with a waste chamber and a suitable water inlet for the continuous, controlled, measured passage of waste.

2,530,170. Shipping crate for animals. Leland C. Miller, assignor to Midwest Game Company, Inc., Kansas City, Mo. Filed March 15, 1948. 3 claims. (Cl. 229-16.)

2,530,261. Fireproofing and creaseproofing of cellulose and protein textiles. Thomas H. Morton and Frank Ward, assignors to Courtaulds Ltd., London, England. Filed Nov. 27, 1948. 8 claims. (Cl. 8-116.2.) The aqueous fireproofing solution contains 5 to 40% of a strong mineral acid and 8 to 25% of cyanamide.

2,530,319. Paper-cutting machine. Irvin L. Young, Chicago, Ill. Filed Nov. 16, 1945. 8 claims. (Cl. 164-61.) A machine for cutting a continuous paper web into seals or stickers for packages.

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2,530,552. Soldering method for positioning strip material. William B. Stoddard, Jr., assignor to The Champion Paper and Fibre Company, Hamilton, Ohio. Filed Jan. 8, 1946. 8 claims. (Cl. 204-286.) A method is given for holding opposed edges of Fourdrinier wires in place for electrolytic welding.

2,530,787. Paper container. Roy S. Sanford, assignor of one half to Ex-Cell-O Corporation, Detroit, Mich., and one half to Ace Carton Corporation, Chicago, Ill. Filed Dec. 6, 1945. 8 claims. (Cl. 229-5.5.) A method of sealing the end flaps of a liquid- or siftproof container.

2,530,809. Fractionation of tall oil. Roger M. Christenson and Stewart W. Gloyer, assignors to Pittsburgh Plate Glass Company, Allegheny County, Pa. Filed Aug. 23, 1949. 6 claims. (Cl. 260-97.7.) A method of separating the sterol fraction of tall oil.

2,530,810. Separation of unsaponifiable matter from tall oil residue. Roger M. Christenson and Stewart W. Gloyer, assignors to Pittsburgh Plate Glass Company, Allegheny County, Pa. Filed Aug. 23, 1949. 9 claims. (Cl. 260-97.7.) The distillation residue, containing 10 to 30% unsaponifiable matter, is saponified, taken up in 15 to 36% aqueous isopropyl alcohol, and extracted with naphtha.

2,530,956. Electrographic recording. Robert B. Gibney, assignor to Bell Telephone Laboratories, Inc., New York, N. Y. Filed Aug. 6, 1946. 7 claims. (Cl. 204-2.) Paper is impregnated with a mixture of 100 parts acetamide and 10 parts formamide; one of the two sheets forming the recording medium also contains 2 parts of Victoria blue.

2,530,986. Plaster of Paris containing paper and method of making. Edmund Q. Moses, Scarborough, N. Y. Filed Aug. 12, 1944. 7 claims. (Cl. 92-3.) Pulp is mixed with up to 50% of gypsum, formed into a sheet, and heated at 120 to 130°F. to convert the gypsum into plaster of Paris.

2,530,994. Electronic control system for dynamoelectric machinery. Walter G. Roman, assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa. Filed April 19, 1949. 13 claims. (Cl. 318-317.) A control system for driving a paper machine is described.

2,531,016. Treatment of fibro-cement products. Otto H. Waechter, North Plainfield, N. J. Filed Sept. 15, 1945. 3 claims. (Cl. 92-68.) A method is given for heating and pressing asbestos-cement products.

2,531,090. Bobbin box. William E. Turner, assignor to O. B. Andrews Company, Chattanooga, Tenn. Filed May 1, 1948. 6 claims. (Cl. 229-27.) A box formed from an integral paperboard blank is designed to hold four bobbins.

2,531,255. Container and display insert. John D. Clarke, assignor to Morris Paper Mills, Chicago, Ill. Filed March 7, 1945. 3 claims. (Cl. 229-23.) The construction of a display container is described.

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2,531,504. Separator for electric storage batteries. Edward R. Dillehay and Robert D. Schuetz, assignors to The Richardson Company, Lockland, Ohio. Filed June 12, 1944. 1 claim. (Cl. 136-145.) The separator consists of a cellulosic sheet saturated with a partially polymerized furfuryl alcohol; the finished sheet contains 25 to 70% resin solids.

2,531,507. Tray type collapsible carton. Charles H. Goodyear, assignor to Fibreboard Products, Inc., San Francisco, Calif. Filed Nov. 13, 1948. 2 claims. (Cl. 229-33.) A carton for frozen foods.

2,531,555. Article-forming system. Roy W. Cummings and George F. C. Burke, assignors to United Shoe Machinery Corporation, Flemington, N. J. Filed May 3, 1946. 51 claims. (Cl. 93-84.) An apparatus is designed for the high-speed production of corrugated paper filters for gas masks.

2,531,619. Machine for decurling labels. Harold A. Gonia, assignor to Beech-Nut Packing Company, Canajoharie, N. Y. Filed June 28, 1946. 1 claim. (Cl. 92-70.) An apparatus for flattening or decurling of paper labels for chewing gum packages.

2,531,630. Cream remover. John P. Jones, assignor to Dairy Specialities, Inc., Omaha, Neb. Filed June 18, 1945. 9 claims. (Cl. 222-484.) A paper milk bottle has a paperlike sheet secured over the inner wall strip opening.

2,531,671. Liner for mess kit covers. Ralph T. Dahl, Portland, Ore. Filed Oct. 7, 1946. 1 claim. (Cl. 65-15.) The liner is a moisture-resistant, thin parchment paper.

2,531,792. Shipping container. Roscoe B. Smith, assignor to Hercules Powder Company, Wilmington, Del. Filed Dec. 10, 1946. 4 claims. (Cl. 206-46.) A laminated paper shipping container for large explosive cartridges.

2,531,914. Method and mechanism for closing fiber containers with a lined closure. Eric W. Lager, James J. Prohaska, and Heinrich E. Haase, assignors to Swift & Company, Chicago, Ill. Filed Feb. 1, 1945. 22 claims. (Cl. 226-81.) A machine is provided for producing a tacky bead around the open end of a cylindrical fiber container, applying a liner over the open end, and placing a cap over the liner to close the container (for shortening).

2,531,931. Composite material. William C. Arkell, assignor to Arkell Safety Bag Company, New York, N. Y. Filed June 1, 1946. 8 claims. (Cl. 154-55.) A paper web with transverse crinkles is covered on each side with unspun cotton fiber web; the product is suitable for bandages, blankets, and the like.

2,531,968. Ornamental box. Jacques Byck, New York, N. Y. Filed March 2, 1948. 1 claim. (Cl. 229-8.) A method of applying an ornamental panel to a box.

2,532,010. Determination of moisture contents. Frédéric Courvoisier, Zurich, Switzerland. Filed July 1, 1947. 12 claims. (Cl. 34-45.) A method of applying an electrostatic voltage for the determination of the moisture content of a running paper web.

2,532,085. Ventilated cardboard carton. Norman Carter, Desborough, England. Filed June 13, 1946. 4 claims. (Cl. 229-16.) A method of forming boxes which assures ventilation when they are stacked.

2,532,101. Method for separating rosin acids from mixed materials. Nicholas L. Kalman, assignor to Pierce Laboratory, Inc., New York, N. Y. Filed Dec. 1, 1947. 26 claims. (Cl. 260-97.6.) Tall oil is dissolved in acetone and the rosin acids are precipitated with cyclohexylamine at 10 to 30°C.

2,532,140. Process of coating paper. William H. Barrett and Bernard K. Asdell, assignor to Minnesota and Ontario Paper Company, Minneapolis, Minn. Filed Nov. 24, 1943. 5 claims. (Cl. 117-103.) A method of applying a mineral coating with a solids content of 61 to 72% to a traveling web of paper, drying on a heated drum drier, and redistributing the moisture content while on the drier drum with a moving felt.

2,532,152. Thin paper insulated electric cable. Louis Domenach and Louis Macardier, assignors to Compagnie Generale D'Electricite, Paris, France. Filed Sept. 11, 1946. 12 claims. (Cl. 174-25.) The dielectric layer consists of narrow strips of thin paper from flax waste and oil under high pressure (10 to 20 kg./sq. cm.).

2,532,248. Fibrous polishing device. Frederick A. Upper and Richard A. Baumgartner, assignors to The Carborundum Company, Niagara Falls, N. Y. Filed June 11, 1948. 7 claims. (Cl. 51-193.) Layers of nonabrasive fibrous sheet material are bonded with a resilient binder alternated with similar material bonded with a nonresilient binder.

December 5, 1950

2,532,415. Rotary screening drum. Karl R. Lindblad, assignor to Svenska Cellulosa Aktiebolaget, Stockholm, Sweden. Filed April 19, 1946. 4 claims. (Cl. 92-36.) A rotary screening drum consists of a cylindrical screening shell and a central shaft carrying the shell; spray pipes inserted through the end walls but not participating in the rotation of the drum are adapted to flush the coarse material collecting on the outer side of the drum to a conveying channel located above the trough.

2,532,446. Bottle carrier. Maynard G. Hall, assignor to Empire Box Corporation, Garfield, N. J. Filed Oct. 2, 1947. 7 claims. (Cl. 229-28.) A collapsible, multicompartment cardboard bottle carrier incorporates central bottle separators, two of which function as handle sections.

2,532,479. Method and machine for gluing and folding paper boxes. Frank H. Burgess, Philadelphia, Pa. Filed Jan. 8, 1947. 8 claims. (Cl. 93-49.)

2,532,494. Method of making paper tubes. Elmer G. Hensler, Barton, Wis., assignor to McGraw Electric Company. Filed Nov. 23, 1946. 1 claim. (Cl. 92-66.) Paper tubes are formed by winding paper pulp on metal sleeves.

2,532,522. Method and mechanism for folding paper boxes. Edwin G. Staude, assignor to The Sperry Corporation, New York, N. Y. Filed Dec. 28, 1946. 9 claims. (Cl. 93-49.) An apparatus for infolding paper boxes in which tabs on diagonal crease lines of adjacent side panels may be reversed or folded back onto the exterior of the infolded side panels.

2,532,658. Winding spool. Albert P. D. Belanger, assignor to Alton Box Board Company, Alton, Ill. Filed Sept. 13, 1947. 4 claims. (Cl. 242-119.) A winding spool for cord and the like consists of a paperboard, cup-shaped structure with parallel side-wall sections.

2,532,784. Bagmaking machine. Herbert L. Reitzes, assignor to Globe Products Heat Seal Corporation, Los Angeles, Calif. Filed April 30, 1946. 3 claims. (Cl. 93-18.) Heat sealing means for a bagmaking machine.

2,532,808. Foldable tray blank and tray. George G. Grinnell, Quincy, Mass. Filed Nov. 5, 1948. 6 claims. (Cl. 229-31.) The tray is adapted for tomatoes and other fruit.

2,532,885. Vortex type separator for paper pulp. André C. Bergès, Mimisan-Plage, France. Filed April 9, 1948. 11 claims. (Cl. 92-28.) The separator consists of several upright cylindrical vortex vessels, each having, at the upper end, a tangential inlet for pulp and a central outlet for withdrawing purified pulp; each vessel has a tangential side outlet for discharging dirt-laden liquid.

2,532,910. Apparatus for drying paper, paperboard, pulp, and the like. Ralph A. Hayward, assignor to Kalamazoo Vegetable Parchment Company, Parchment, Mich. Filed Sept. 2, 1947. 5 claims. (Cl. 34-68.) The number of drier rolls in a paper machine is reduced by the inclusion of a vacuum roll after a suitable number of initial heating rolls.

2,532,923. Method of making paper yarn. Harry D. Kitchen, Grand Rapids, Mich., assignor to Sackner Products, Inc. Filed Jan. 24, 1949. 9 claims. (Cl. 57-165.) A variegated paper yarn is formed from a single ribbon or strip of paper.

2,533,070. Carton. Walter J. Tyrseck, assignor to Robertson Paper Box Company, Inc., Montville, Conn. Filed Oct. 26, 1949. 10 claims. (Cl. 229-14.) A shockproof or cushioned paperboard carton is adapted for packaging bottles and the like.

2,533,145. Stereotype mat. Arlie W. Schorger, assignor to Burgess Cellulose Company, Freeport, Ill. Filed April 13, 1948. 6 Claims. (Cl. 22-5.5.) Cellulosic fibers are impregnated with water-insoluble cellulose hydroxyalkyl ether (ethyl to propyl); there are 0.25 to 1.5 hydroxyalkyl radicals for each unit of cellulose.

2,533,199. Hydraulic seal for pulp refining mills. Cyrus E. Roberson, assignor to The Noble & Wood Machine Company, Hoosick Falls, N. Y. Filed Jan. 9, 1947. 2 claims. (Cl. 286-9.) A sealing structure is interposed between the rotor and stator elements of the machine, which is designed to prevent the leakage of stock at that point.

December 12, 1950

2,533,255. Opening means for cigarette wrappers. Theodore A. Will, Hollis, N. Y. Filed July 20, 1946. 2 claims. (Cl. 229-51.) A tear strip for cigarette wrappers.

2,533,340. Egg carton. William H. Allen and Maynard G. Hall, assignors to Empire Box Corporation, Garfield, N. J. Filed Jan. 24, 1947. 12 claims. (Cl. 229-28.) A carton can be divided transversely into two egg-carton sections.

2,533,433. Web former and cutter for satchel bottom paper bags. Converse V. Clark, assignor to The Chase Bag Company, New York, N. Y. Filed June 8, 1945. 3 claims. (Cl. 93-19.) The usual variation in the distance between thumb cuts from one bag to the next is eliminated by the location of the thumb-cut knife at the back end of the machine, adjacent to the cutoff knife.

2,533,539. Resealable carton closure having metallic clip fastening means. George S. Vivian, assignor to Satona Ltd., Leeds, England. Filed July 17, 1945. 1 claim. (Cl. 229-65.) A wedgelike, pleated top of a container is sealed with a U-section clip over the peak of the top.

2,533,642. Lined container forming machine. John G. Vergobbi, assignor to Pneumatic Scale Corporation, Ltd., Quincy, Mass. Filed Jan. 19, 1949. 3 claims. (Cl. 93-36.01.) The apparatus embodies one or more forming blocks around which the liner and the carton are formed in successive operations.

2,533,773. Ventilated corrugated board container. Norman F. De La Foret, assignor to The Ottawa River Paper Company, Toledo, Ohio. Filed July 16, 1949. 3 claims. (Cl. 229-6.) The container is perforated to permit the exchange of air without appreciably weakening of the walls.

2,533,993. Roll crimping machine. Harry C. Bryans, assignor to Canadian International Paper Company, Montreal, Quebec, Canada. Filed Nov. 8, 1949. 6 claims. (Cl. 93-5.) A machine for crimping the projecting ends of wrapping material over the ends of a roll of paper.

2,534,008. Insecticidal paper-coating composition. George W. Fiero, Howard F. Seeland, and George H. Batt, assignors to Standard Oil Development Company, New York, N. Y. Filed July 10, 1947. 1 claim. (Cl. 106-15.) The composition contains (in parts): dichlorodiphenyltrichloroethane 20, clay 19, suspending and wetting agent 2.5, octyl alcohol 0.2, chlorinated starch solution 8.8, and water 50.

2,534,010. Reusable pallet bin. De Moine H. Frye, assignor to Leslie T. Swallow, Detroit, Mich. Filed April 26, 1946. 3 claims. (Cl. 229-23.) A reusable shipping and storage carton comprises separate interlocking sections, several of which can be stacked to provide a multilayer bin.

2,534,011. Reusable pallet bin. De Moine H. Frye, assignor to Leslie T. Swallow, Detroit, Mich. Filed July 25, 1946. 2 claims. (Cl. 229-23.) The bin can be assembled in any desired size by the addition or removal of a selected number of sections.

2,534,052. Method of forming one-piece paper containers. Jesse Norden, Woodmere, N. Y. Filed June 24, 1948. 4 claims. (Cl. 93-60.) A paper milk container is formed of paraffin-impregnated paper.

2,534,201. Carton having metal corrosion inhibiting characteristics. Clemens A. Hutter, assignor to Rust Chemical Company, Chicago, Ill. Filed Nov. 1, 1949. 9 claims. (Cl. 229-3.5.) The inner wall is impregnated with one part of an inorganic metal nitrite and 0.05 to 20 parts of an organic amide (acetamide, urea, guanidine, and the like).

December 19, 1950

2,534,320. Apparatus for coating paper. William P. Taylor, assignor to The Champion Paper and Fibre Company, Hamilton, Ohio. Filed May 16, 1946. 3 claims. (Cl. 91-53.) A method of coating high-grade printing papers; coatings of normal or unusually high solids content can be utilized.

2,534,321. Coating method and apparatus. William P. Taylor, assignor to The Champion Paper and Fibre Company, Hamilton, Ohio. Filed May 16, 1946. 8 claims. (Cl. 117-111.) In a coating apparatus, a doctor blade is so held that it indents a rubber carrier surface slightly as the latter passes under the blade.

2,534,324. Process for separating cooking liquor from pulp. Paul G. von Hildebrandt, Port St. Joe, Fla. Filed July 2, 1945. 8 claims. (Cl. 8-156.) Steam is diffused through the moving mass of pulp and the liquor is drained from the pulp. The black liquor is thus obtained with minimum dilution.

2,534,402. Collapsible box. Fletcher Blair, Atlanta, Ga. Filed Jan. 10, 1947. 1 claim. (Cl. 229-41.) A display container for crackers, cookies, and the like.

2,534,563. Filter drum and shielding shoe. Josef V. Vitalius and Nils Klykken, assignors to Aktiebolaget Kamyr, Karlstad, Sweden. Filed Feb. 14, 1948. 4 claims. (Cl. 210-202.) A rotary pulp screen has a stationery shield or baffle plate which shields a portion of the inner surface of the screen shell where the web of material is removed from the outer face of the screen.

2,534,588. Paper base planographic printing plate. Frederick H. Frost, assignor to S. D. Warren Company, Boston, Mass. Filed July 14, 1947. 15 claims. (Cl. 101-149.2.) A wet-strength paper base is coated with a finely divided filler dispersed in a hydrophilic colloidal adhesive.

2,534,650. Planographic printing plate and method of making same. Stephen V. Worthen, assignor to S. D. Warren Company, Boston, Mass. Filed June 26, 1950. 21 claims. (Cl. 101-149.2.) A printing plate which has a surface coating of a finely divided filler in a hydrophilic adhesive is treated with an ammonia complex such as cuprammonium chloride in an amount in excess of that capable of reacting with the adhesive.

2,534,743. Sand mold composition. Shirley M. Vincent, assignor to Monsanto Chemical Company, St. Louis, Mo. Filed Nov. 13, 1948. 5 claims. (Cl. 22-188.) The binder for foundry sand consists of the reaction product of glycerin and the product obtained from 500 to 3000 parts of a tall oil vinyl ester and 100 parts of maleic anhydride.

2,534,805. Coated abrasive articles and backing for such articles. Donald A. Waterfield, assignor to Behr-Manning Corporation, Troy, N. Y. Filed March 10, 1947. 9 claims. (Cl. 51-297.) Two plies of 65-pound rope Fourdrinier paper are laminated with a mixture containing 26.2 pounds of glue, 7.3 pounds of dextrin, 44.2 pounds of calcium carbonate, and 22 pounds of water.

2,534,806. Coated abrasive articles. Charles S. Webber and William F. Timmer, assignors to Behr-Manning Corporation, Troy, N. Y. Filed July 18, 1947. 8 claims. (Cl. 51-298.) The binder for sandpaper, emery cloth, and the like incorporates an adhesive made of starch.

2,534,848. Process for coating paper. William H. Barrett

and Bernard K. Asdell, assignors to Minnesota and Ontario Paper Company, Minneapolis, Minn. Filed Nov. 15, 1946. 2 claims. (Cl. 117-111.) A process of coating one side of a moving web of paper (with a moisture content of less than 10%) with two small films of mineral adhesive coating composition with a solids content in excess of 60%.

2,534,908. Method of the manufacture of molded articles. Tibor Holzer, Zurich, Switzerland. Filed Aug. 28, 1946. 10 claims. (Cl. 106-123.) Sulphite waste liquor is used in the manufacture of molded products from shavings, cork powder, and the like.

December 26, 1950

2,535,026. Moisture determination. Wilmer C. Anderson, assignor to Deering-Milliken Research Trust, New York, N. Y. Filed Feb. 21, 1947. 7 claims. (Cl. 175-183.) The moisture content of a continuous web of paper is determined as a function of the change in capacitance and equivalent series resistance of a condenser as the web passes between the plates of the condenser.

2,535,027. Apparatus for measuring and controlling moisture content or the like. Wilmer C. Anderson, assignor to Deering-Milliken Research Trust, New York, N. Y. Filed March 27, 1947. 15 claims. (Cl. 34-52.) An apparatus is designed for controlling the moisture content of a paper web in response to changes in the capacitance and equivalent resistance of a condenser which result from the passage of the web between the plates of the condenser.

2,535,056. Carton. William P. Frankenstein, Cincinnati, Ohio. Filed Oct. 22, 1947. 10 claims. (Cl. 229-34.) A knocked-down carton can be set up to provide an extending flange around the base of the carton and the upper edge of the lid.

2,535,240. Feeding mechanism. William R. Spiller and Edwin W. Bradmiller, assignors to Harris-Seybold Company, Cleveland, Ohio. Filed Jan. 20, 1945. 28 claims. (Cl. 164-48.) A method for feeding sheets of paper to a trimmer.

2,535,289. Division plate. Leo Hopp and Estelle Mallman, assignors to The Hopp Press, Inc., New York, N. Y. Filed Feb. 7, 1948. 5 claims. (Cl. 229-28.) A member for dividing the interior of a receptacle into cells.

2,535,302. Disintegrator of laboratory test size for wet disintegration of cellulosic pulp samples. Robert M. Levy and Ward D. Harrison, assignors to Ecusta Paper Corporation, New York, N. Y. Filed May 3, 1944. 2 claims. (Cl. 92-22.) A disintegrator for the preparation of wet pulp samples for viscosity determination.

2,535,413. Box forming machine. George T. Hart and Malcolm Seymour, assignors to United Shoe Machinery Corporation, Flemington, N. J. Filed March 9, 1945. 2 claims. (Cl. 93-49.) A semiautomatic box and forming machine.

2,535,537. Envelope. Vincent E. Heywood, assignor to United States Envelope Company, Springfield, Mass. Filed April 25, 1947. 1 claim. (Cl. 229-80.)

2,535,647. Treating clay. Nathan Millman and James Brooks, assignors to J. M. Huber Corporation, Huber, N. J. Filed June 14, 1947. 6 claims. (Cl. 106-72.) A mixture of 115 to 210 volumes of clay and 100 volumes of water containing 0.05 to 1% of a peptizing agent is kneaded at a rate such that the temperature of the mixture rises at a rate of 5°C. in 5 minutes.

2,535,690. Fibrous dielectric compositions. Harry F. Miller and Ralph G. Flowers, assignors to General Electric Company, Schenectady, N. Y. Filed Aug. 2, 1947. 8 claims. (Cl. 117-154.) A dielectric material results from the reaction of a wood pulp with acrylonitrile in an alkaline medium; the nitrogen content may vary from 0.3 to 2.8%.

2,535,730. Process for the treatment of waste liquors derived from cellulose manufacture. René H. Gadret, assignor of one half to Papeteries de Gascogne (Société Anonyme), Mimizan, France. Filed Sept. 28, 1948. 5 claims. (Cl. 23-48.) A method of evaporating and burning black liquor in which a swirling suspension is introduced into a chamber at a temperature from 280 to 500°C.

2,535,732. Sealed wet end for paper machines. John E. Goodwillie assignor to Beloit Iron Works, Beloit, Wis. Filed Feb. 13, 1946. 6 claims. (Cl. 92-43.) A sealed wet end of a paper machine consists of a rotatable foraminous cylinder, a forming wire trained around the cylinder, a stock chest communicating with the forming wire on the ascending side of the cylinder, a couch roll, a sealing roll, and means for introducing gas under pressure into an enclosed space above the cylinder.

2,535,734. Apparatus for creping paper and other crepable foils. Karl E. L. Grettve, Lilla Edet, Sweden. Filed July 12, 1945. 3 claims. (Cl. 154-30.)

2,535,738. Slice roll assembly for paper machine presses. George F. Hrubecky, assignor to Beloit Iron Works, Beloit, Wis. Filed Jan. 30, 1947. 10 claims. (Cl. 92-49.) A slice roller is rotatably mounted immediately in advance of the nip of a paper machine press.

2,535,741. Bottle carrier. Stephen Lighter, Whitefish Bay, Wis. Filed Oct. 28, 1946. 5 claims. (Cl. 229-28.)

2,535,815. Mill roll stand. Edward B. Seeger, assignor to Samuel M. Langston Company, Camden, N. J. Filed Oct. 15, 1947. 1 claim. (Cl. 242-58.)

2,535,970. Paper machine. Bruno Trevisan, assignor to Papierfabrik Balsthal A. G., Balsthal, Switzerland. Filed Sept. 13, 1947. 7 claims. (Cl. 34-119.) A drying system consists of a series of cylinders and means for passing heating water continuously through the cylinders countercurrent to the travel of the paper web.

Paper and Packaging Specifications

U. S. GOVERNMENT SPECIFICATIONS

Following is information from B. W. Scribner, National Bureau of Standards, Chairman, Technical Committee on Paper and Paper Products, Federal Specifications Board, on revised Federal specifications of recent issue:

UU-T-591b (revison), Towels, Paper, Price 5 cents.

One type only, wet-strength towels, is now specified. Changes have been made in the sizes of singlefold and multifold towels, the sizes of C-fold towels remaining unchanged. The absorption time for 0.1 ml. of water has been reduced to 100 seconds, and a stretch requirement of 5% has been added. The revision was developed with the assistance of the Technical Committee of The Tissue Association.

UU-P-556c (revision), Paper, Toilet Tissue, Price 5 cents.

The types are now confined to roll and sheet tissue. The oval type was deleted because of the small use of it by the Government agencies. Two classes of roll tissue, differing in strength and absorptiveness, are now specified. A brightness requirement of 60% is now specified for the more absorptive class. This revision was also developed with the assistance of the Technical Committee of The Tissue Association.

UU-P-252a (revision), Paper, Impervious; Paraffined (for Surgical Dressings), Price 5 cents.

Changes have been made in content of paraffin and in bursting strength, and requirements for tearing resistance and water resistance have been added.

UU-T-91 (new), Tape, Double-Coated, Pressure-Sensitive, Price 5 cents.

This tape is suitable for mounting work for photographic reproduction and other uses when two-sided adhesion is required. One type has a transparent film base and the other has an opaque paper base. Both types have on both sides an adhesive requiring no moisture, heat, or other manner of preparation prior to application. The requirements include adhesiveness, resistance of the adhesive to accelerated aging by high temperature and humidity and by light, and tensile strength. Other pressure-sensitive tapes covered by Federal specifications comprise shielding and identification, drafting, photographic, masking, and mending (5 cents each). These were all developed with the assistance of manufacturers.

UU-D-723 (new), Drums, Fiberboard (Domestic Type), Price 5 cents.

This specification covers drums to be used for domestic shipments. The three types specified are for, respectively, dry or solid materials, semisolid materials, and hot-poured materials that solidify on cooling. The drums have a sidewall made of fiberboard and heads made of wood, fiberboard, or metal. The detailed requirements include construction, capacities for the various weights of contents specified, and the thickness and bursting strength of the component parts.

(Copies of Federal specifications and the Federal Specifications Index may be obtained on application accompanied by postal note, money order, coupon, or cash to the Superintendent of Documents, Government Printing Office, Washington 25, D. C. The price of the Index is 35 cents.)

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Calendar of TAPPI Meetings

NATIONAL

First Corrugated Container Conference, Statler Hotel, Cleveland, Ohio. May 18, 1951
General Chairman, F. D. Long, Container Corp. of America, Chicago, Ill.

Alkaline Pulping Conference, John Marshall Hotel, Richmond, Va. September 26–28, 1951
General Chairman—Henry Vranian, Chesapeake Corp., West Point, Va.
Program Chairman—R. R. Fuller, Gulf States Paper Co., Tuscaloosa, Ala.

Sixth Engineering Conference of the Pulp and Paper Industry, General Oglethorpe Hotel, Wilmington Island, Savannah, Ga., October 15–18, 1951
General Chairman—George H. Pringle, Mead Corp., Chillicothe, Ohio
Local Arrangements Chairman—James R. Lientz, Union Bag & Paper Co., Savannah, Ga.

LOCAL SECTIONS

Delaware Valley Section:
May 26, 1951, Engineers Club, Philadelphia, Pa.

Chicago Section:
May 21, 1951, Chicago Bar Assoc., Chicago, Ill.

Maine-New Hampshire Section
June 22–23, 1951, Eastern Slope Inn, N. Conway, N. H.

Empire State Section:
June 28–30, 1951, Whiteface Inn, Lake Placid, N. Y.

New England Section:
June 8–9, 1951, The Griswold, Groton, Conn.

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ROW*	BUTADIENE-STYRENE RATIO	COLUMN# A	COLUMN# B	CHARACTERISTICS AND USES
1.	0/100	220RS	220NS	Discontinuous, flaky film.
2.	20/80	398-20RS	398-20NS	Discontinuous film, Reinforcer and drier.
3.	30/70	335-30RS	335-30NS	Continuous, slightly flexible film. Tough and horny. Reinforcer and drier.
4.	35/65	350	350-35NS	Continuous, clear to slightly hazy film. Tough and flexible with no tack. Base for water. Paints and paper coatings.
5.	40/60	350-S	350-N	Continuous, clear to slightly hazy film. Tough and flexible with slight tack. Paint, paper, leather and textile coatings.
6.	50/50	417-50RS	417-50NS	Continuous clear film. Tough and flexible with slight tack.
7.	70/30		397-70NS	Continuous, clear film. Very flexible. Extender for GRS and natural rubber. Adhesive base.
8.	100/0		418-100NS	Excellent extender for GRS and natural rubber latices.

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#Column B lists latices stable to acids and metal-ions. Latices in A and B available at 45% total solids content.

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